THE

AËRONAUTICAL JOURNAL

A Quarterly Illustrated Magazine devoted to all subjects connected with the Navigation of the Air

EDITED FOR THE COUNCIL OF THE AËRONAUTICAL SOCIETY OF GREAT BRITAIN

BY

T. O'B. HUBBARD AND J. H. LEDEBOER, B.A.

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Notices of the Aëronautical Society of Great Britain

GENERAL NOTICES

November Elections:—A. E. BERRIMAN; H. HARPER.

December Elections:—CAPT. C. J. BURKE; HORACE DARWIN; PROFESSOR J. E. PETAVEL.

January Elections:—JOHN HIRST; SIR GEORGE WHITE, Bart.; SAMUEL WHITE, J.P.; GEORGE S. WHITE.

The following letter from the late Mr. Octave Chanute acknowledging the receipt of the Society's Gold Medal was received shortly before the sad news of his death, which occurred at Chicago on November 23, 1910. A letter of condolence has been despatched to his relatives by the President on behalf of the Society.

Chicago, Ill. October 29th, 1910

THE SECRETARY, AËRONAUTICAL SOCIETY OF GREAT BRITAIN

DEAR SIR,

In consequence of delays in the United States Customs, I only received last evening the superb gold medal awarded to me for services in Aëronautical Science by your Society and kindly forwarded to me at Paris by yourself at the end of September.

I am deeply touched by this great honour conferred upon me, and regret exceedingly that I was unable to attend the dinner at which you had planned to present me with this mark of regard.

I am still very weak and feeble, being confined to my bed, from the attack of pneumonia from which I suffered while abroad, but I hope I am slowly recovering my health.

Please thank for me the Council and the Members of the Aëronautical Society of Great Britain, for this kind appreciation of my work and express to them my best wishes for the continued success and prosperity of the Society.

Yours faithfully,
(Signed) OCTAVE CHANUTE

The President, on behalf of the Society, has sent a letter of condolence to the relatives of the late Mr. Cecil Grace, who was lost at sea on the return flight from France on December 22, 1910.

A cable of condolence was despatched to the Aëronautical Society of America on the occasion of the fatal accidents to J. B. Moisant and A. Hoxsey on December 31, 1910. The following reply has been received:—

The Aëronautical Society of Great Britain

16 January, 1911

GENTLEMEN,—

We gratefully acknowledge receipt of your cable. The sentiments that prompted this message are sincerely appreciated. It is highly regrettable that the year 1910, so memorable for the vast advance made by aviation, should be memorable also for the loss of so many of the bravest and most capable aviators. But the useful lessons that have been taught are many,

and by the proper dissemination of this knowledge, we shall be able continually to lessen the human sacrifice. We believe that an especial effort should be put forth toward the highest utilization of the knowledge so dearly bought, and we know that you, the oldest organization in the world devoted to this art, will unite with us, heart and hand, both in sympathy and in effort.

Yours most cordially,

The AËRONAUTICAL SOCIETY,

HUDSON MAXIM (President)

LEE S. BURRIDGE (1st Vice-President)

The Society's Bronze Medal, given annually for the best paper appearing in the AËRONAUTICAL JOURNAL, has been awarded for 1910 to Mr. Bertram G. Cooper for his paper entitled "Some Principles of Propulsion," which appeared in the issue of July last.

A telegram conveying the Society's congratulations was despatched to Mr. S. F. Cody on the occasion of his winning the British Empire Michelin Cup by his flight of 185 miles 787 yards on December 31, 1910.

At a meeting of the Council held on January 9, 1911, the following resolution was passed and ordered to be communicated to Lieut. J. W. Dunne :—

> "That Mr. J. W. Dunne has proved in a great measure the automatic stability of his biplane and the Council of the Aëronautical Society of Great Britain congratulate him on his unique achievements, in successfully writing notes during flight with his hands off the levers, and in making a gliding descent with his hands held above his head."

The official report and other papers connected with the Dunne biplane are printed in the present issue.

Balloting papers for the election of President, Vice-Presidents and Officers for 1911 will be circulated during February in accordance with the new constitution of the Society. All members are earnestly requested to record their votes on this occasion. The Annual General Meeting at which the elections will be announced will be held on March 31, at 8 p.m., at the Royal Society of Arts.

"'Gliding' by Percy S. Pilcher, to which is added the Aëronautical Work of John Stringfellow" has been published by the Society as No. 5 of the "Aëronautical Classics" series.

COMMITTEE NOTICES

Bird Construction Committee The report of this Committee is now in the press and will shortly be issued. Owing to its form, length and nature it has been found impossible to print it in the AËRONAUTICAL JOURNAL. It will therefore be published in pamphlet form only.

Laboratory Committee The Laboratory Committee beg to tender their thanks to Messrs. Wm. Mallinson and Son, who have forwarded samples of various woods for experimental tests.

Technical Terms Committee The Terms Committee have completed their preliminary report which has been issued to the Press. This report is printed in the present issue.

LIBRARY NOTICES

The Council of the Society desire to thank the following donors for their gifts to the Library :—The President, Mr. E. P. Frost, for a fine stuffed specimen of condor-vulture; Colonel J. E. Capper, C.B., for a set of lantern slides; Colonel F. C. Trollope, for papers and pamphlets; and Major B. Baden-Powell for an old oil-painting of a landscape with a balloon in flight.

OBITUARY OF MEMBERS

THE LATE M. JACQUES FAURE

THE LATE MR. CECIL GRACE

CECIL GRACE

WE have to deplore the loss of another of that gallant little band of gentlemen amateurs, who, in the early days of flying, became pioneers of the new art in this country, and worthily upheld the honour of Great Britain in the air.

Cecil Grace, son of the late J. W. Grace, was born in Valparaiso some twenty-six years ago, and his first interest in flying dated, like that of so many others, from the historic Rheims meeting of 1909. He established himself first at Shellbeach and later at Eastchurch, speedily becoming one of the finest aviators in the world. He flew at the Wolverhampton, Bournemouth, Lanark, and Leopardstown meetings, and was equally at home on a monoplane and on a biplane, though the latter was his favourite; in fact he was the designer of an improved Farman type machine which was nearly completed at the time of his death. On December 22nd last he started from Swingate Downs near Dover, in the competition for the Baron de Forest Prize—£4,000 for the longest flight across the Channel into the Continent. He reached Les Baraques, a little village not far from Calais, and there descended owing to the adverse wind. Shortly after two, he started to fly back to be ready for another attempt, but mist hung over the Channel, and there was a steady cross-wind which carried him out of his course. About three o'clock his biplane was sighted for a moment from Ramsgate heading north, and from that moment no news has come, save the mute testimony of his cap and goggles washed up on the French shore.

In our memories he will live eternally young, he will ride out for ever triumphantly over the Channel. From his brief but splendid career we can draw pride and inspiration. We have given hostages to the air, whose conquest shall redeem them, and we have given of our best.

JACQUES FAURE

On December 2nd died at Quebec, Jacques Faure, founder member of the Aéro-Club de France, Hon. Member of the Aëronautical Society.

Born at Meudon, on the outskirts of Paris, on July 23rd, 1873, Jacques Faure, enabled to follow his inclinations from his youth, became an accomplished sportsman in both the English and French senses of the word; yachting, motoring and aeronautics claimed him in turns. His first balloon ascent was made under the tutelage of Count de La Vaul in 1899; already in 1900 he accomplished, in a solo ascent undertaken during the Exhibition, a distance of 740 miles. During the following year he was elected an honorary member of the Aëronautical Society, as recorded in the following minute of January 31st, 1901: "That M. Jacques Faure, Treasurer of the Paris Aero Club, be elected an honorary member of the Society, on account of his eminent work in practical ballooning, having among other remarkable exploits during the past year been the first member of the Paris Aero Club to cross the Channel from the Crystal Palace in August last." Since then he figured prominently in many of the chief aerostatic competitions throughout the world, worthily upholding his reputation as a skilled, though reckless, pilot.

GENERAL MEETING

THE fourth meeting of the forty-fifth session of the Aëronautical Society of Great Britain was held at the Royal Society of Arts, John Street, Adelphi, London, on Tuesday, December 6, 1910, at 8 p.m. Dr. W. N. Shaw, F.R.S., occupied the Chair.

Dr. SHAW, in opening the meeting, said: Before asking Mr. Dines to give us his lecture, I wish to announce that the Bronze Medal of the Society, given annually for the best paper appearing in the AERONAUTICAL JOURNAL has been awarded for the year 1910 to Mr. B. G. Cooper for his Paper on the Principles of Propulsion.

THE PRACTICAL APPLICATION OF METEOROLOGY TO AERONAUTICS

BY W. H. DINES, F.R.S.

I have been asked to-night to give you some account of our present knowledge of the atmosphere, and more particularly in so far as that knowledge is applicable to aeronautics. Much might be said about the atmosphere, but I only propose to discuss its density, temperature and motion.

The air is a gas, or rather, a mixture of gases together with an indefinite amount of water vapour. The water vapour plays an unknown part in the production of wind, and is responsible for the rain and snow which may add a very appreciable load to a balloon; it is perhaps the most important factor in meteorological phenomena, but there is not time to deal with it to-night.

In text-books on physics the following distinction is drawn between a gas and a liquid. A liquid when put into a vessel occupies a definite part of that vessel, but no matter how small a quantity of gas is put into a closed vessel, it will expand and occupy the whole of the vessel.

It has been said that a cormorant always has room for just one more fish, and equally there is always room in a closed vessel for just a little more gas, provided the vessel is strong enough to stand the strain and sufficient force is available to press more in. A given weight of air will always adjust the space it occupies to the pressure to which it is exposed, and it is this property which separates a gas from a liquid, and it has a most important bearing on the behaviour of the atmosphere. The power of the air to support a balloon or a flying machine depends upon its density, that is to say, on the actual quantity of gas divided by the volume it occupies. The layers of air near the earth's surface are squeezed together by the weight of the air above them; more gas, therefore, occupies the same space, or in other words, the density is greater than it is above. From this property of air it follows that there is no precise upper limit to the atmosphere. If air were of the same density throughout, it would reach to a height of about five miles, but as it is there is still some air left at a height approaching 200 miles. This is known from the fact that shooting stars do not become visible until their motion is opposed by the air, and since the height of many shooting stars when first seen is found to be 150 miles or more, we know that there is some air at that height, although it must be extremely rarified. Besides their power of adapting the space they occupy to the pressure to which they are subjected, gases possess another property. If a gas is compressed into a smaller space it becomes hot, and when it expands so as to occupy a larger space it becomes cold. This is well known to those who use compressed air for any purpose: large quantities of water are required to keep the cylinders in which the air is compressed cool, and where tools are driven by compressed air, the tool becomes unpleasantly cool to the hand of the workman.

The relation between the volumes before and after and the corresponding temperatures is given by the formula:

$$\left(\frac{V_1}{V_2}\right)^{\cdot 408} = \frac{T_2}{T_1}$$

where T_2 and T_1 are temperatures measured from the absolute zero. Thus if air at the freezing point has its volume doubled its temperature is reduced about 120° F., and if its volume be halved its temperature is raised about 160° F. It has been assumed in the above that the expansion occurs adiabatically, as it is called, that is to say, that the air can neither gain nor lose heat while its volume is changing. This is a condition that cannot be realised in practice so far as air compressors and refrigerating apparatus are concerned, but probably it is very nearly realised in the case where large bodies of air are ascending or descending in the atmosphere, unless the motion be very slow.

This property of air is most important in meteorology; as air comes down from above it is subject to a greater weight of air above it, its pressure is increased, its volume is reduced, and it is warmed. It is a great mistake, but unfortunately even still it is a common one, to think that air from above will be cold because it has come from a cold place. Unless it descends mixed with actual water particles, it will certainly be warm and not cold. It is easy to calculate the change of temperature that occurs with change of height, and it happens very conveniently that it is the same for all heights in the atmosphere. For dry air or at least for air in which clouds are not forming, it is 1° F. for about 200 ft. height; for air in which condensation is occurring it is, under average conditions, at the surface, only half this, namely, ·5 F. for 200 ft. It is owing to this that the mountains are cold, and to this cause also almost every drop of rain that falls is due, for in the constant interchange of air that goes on the air met with at the top of a mountain has recently risen from the plains, and has thereby been made colder than it was when on the plains. If too it chanced to be damp air before it rose the process of cooling will have condensed its moisture and have produced rain or snow.

Our knowledge of the atmosphere has been greatly increased of late years by means of balloons and kites; especially by the former; since the small balloons that are now regularly sent up carrying recording instruments with them reach on the average a height of 10 miles and occasionally a height of 15 miles.

From the information thus obtained I am able to give you the following particulars. The values refer to England, but hardly differ from those obtained on the Continent. At the surface the mean density of the air is such that one cubic foot of it will weigh $1\frac{1}{4}$ ounce, but owing to changes in the temperature and in the height of the barometer this value may be increased or decreased by some 10 per cent. The mean annual temperature in England is close to 50° F. At a height of one mile the density will be about 82, if we take 100 to represent it at sea level, and the temperature rather over the freezing point. At two miles the density is about 66 and the temperature about 20° F. At five miles, and this is about the limit that man has ever reached, the density has sunk to about 35 and the temperature to a value that will probably be between — 20 and — 60. Up to five miles there is certain to be a steady decrease of temperature, but somewhere between five miles and nine miles high a point will be reached beyond which the temperatures will cease to fall. The usual height of this point is seven miles, and the usual temperature is from — 50 F. to — 70 F; but the temperature may be as high as — 40 or as low as — 90 F. At about 15 miles our knowledge from direct observation ceases, but at this point the density is reduced to about $3\frac{1}{2}$ on the scale, and barely one-thirtieth of the whole atmosphere remains above. The temperature is probably about — 60° F.

So far as aviation is concerned we hardly need trouble about the conditions that prevail beyond a height of two miles. The lift that a flying machine moving at a definite speed can obtain is proportional to the density of the air, and the loss of one-third of the supporting power is somewhat serious, so that flying at a height of two miles is in some ways more difficult than at the surface. Still, the actual resistance to forward motion is less, and a greater lift can be obtained by a comparative small increase of speed, and since the resistance is reduced this can be obtained, provided that the engine is sufficiently flexible to develop the same horse-power and at the same time to run much faster. The decrease of density with height is not therefore so great an obstacle to obtaining great heights as one might suppose, and it admits of greater speed. The fall of temperature appears to be a more serious obstacle. The given temperature of 20° F. at a height of two miles is the mean for England; the actual temperature on any given date will depend on the season, whether summer or winter, and is also subject to large casual variations

just as it is at the ground level. Temperatures between 0° F. and 50° F. have been recorded by balloons at this height. The low temperatures increase the density and lessen the viscosity of the air, but these advantages are probably very small in comparison with the general inconvenience caused, and with the necessity for thick and therefore heavy clothing.

Apart from the change of density with height, changes occur from the varying height of the barometer. At sea level in England the barometric pressure may easily vary from 29·00 to 30·50 inches. This is equivalent to a change of 1,500 ft. in altitude. From the practical point of view it is not perhaps a very important amount, but it will undoubtedly be found easier to fly at times of high than at times of low barometer, also at times of high barometer the temperature does not decrease rapidly with height; indeed with a high barometer (anti-cyclonic conditions) the air is sometimes warmer at a height of one mile than on the surface. Also, too, in the event of an accident, there is a rather better chance of its not being so serious at such times, for the denser air checks the velocity of anything falling through it. In the caissons used for building the foundations of the piers of bridges and docks in deep water, where the air is greatly compressed, it is found that men may fall from considerable heights without injury, and did we chance to live on a planet where the density of the air was four or five times as great as it is on the earth, mechanical flight would be quite easy, though the speed of our express trains would be greatly reduced.

But the subject that I more particularly wish to bring to your notice to-night is that of wind, for in the practice of aviation it is certainly wind that is the most important consideration.

The cause of wind is the unequal heating of the earth's surface by the sun's rays, unequal as between the polar and equatorial regions and unequal as between continental and oceanic regions in the same latitude. The sun's rays pass through dry air and exercise on it comparatively little heating effect, but on reaching the earth's surface they warm it, and it in turn warms the air in contact with it. On reaching the surface of the sea they also warm it, but for three reasons the warming is far less than with the earth. Water is not so readily warmed or cooled as the ordinary rocks that form the earth's surface, and it reflects some of the rays. Also in water the wind and waves cause a continual mixing process to go on, so that a layer of water hundreds of feet thick has to be warmed before much change of temperature is shown, whereas on land it is only a thin layer on the surface that changes its temperature. Still, the constant supply of heat from the sun must tell in time, and the equatorial and tropical oceans are maintained at a temperature of about 80° F. with but little change throughout the year. The oceans in temperate latitudes, the North Atlantic for example, have a larger change of temperature, say, 10° F., between summer and winter, but in the centres and eastern parts of large continents, as in Siberia, the difference between summer and winter may amount to 100° F. Warm air is lighter than cold, and therefore, if we suppose the air to reach to the same height at two places, the place where the air is warm will have a lower barometer than the one where the air is cold. Now to maintain a mass of air subject to a definite pressure, that air must be confined in a closed vessel; but the atmosphere is perfectly free and unconfined, save at its lower surface. Hence it would appear as though these differences of pressure could not be maintained in the atmosphere. As a matter of fact, too, places that are covered by warm air do not always have a lower barometer than places covered by cold air. The rule holds roughly for places in the same latitude, but fails entirely when we compare places in different latitudes. A reasonably good explanation of the general circulation of the atmosphere has, in my opinion, never yet been formulated, and with regard to the more local circulation it cannot be said with certainty whether strong winds and gales are produced by differences of barometric pressure, or whether differences of barometric pressure are produced by strong winds; all that I dare safely assert without fear of contradiction is that the heating of the air by the sun's rays, directly and indirectly, is the primary cause of all wind.

Notwithstanding the objection raised above, large differences of barometric pressure are found to exist and to continue between places a few hundred miles apart, and in the space between such places a strong wind is always found to be blowing. This wind does

not blow as might be expected from the place of high to the place of low barometer, but it blows more nearly at right angles to this line.

Owing to the fact of the earth's rotation on its axis all bodies moving freely on the earth's surface except on the equator, have a tendency to turn to the right hand in the northern and to the left hand in the southern hemisphere. This tendency varies as the sine of the latitude—it is greatest near the poles, least near the equator. The most convenient point about it to remember is that no matter what the velocity or what the direction, after a certain time the same change of angle will have occurred. After twenty-four $\times$ sine λ hours, the body, if it had perfect freedom and remained in latitude λ, would have completed its circle and be moving in the same way as before. Thus in this latitude an east wind if unopposed will have turned into a south wind in a little under eight hours.

It is this tendency that causes a cross wind between two places where the heights of the barometer are different, or if you like to put it the other way, that causes the variation of pressure between two places between which a cross wind is blowing.

The term "barometric gradient" means the difference between the heights of the barometer at two neighbouring places divided by the distance between the places. In drawing a weather chart, all places at which the height of the barometer is the same are plotted on the map and lines drawn through them, which are called isobars. The distance between two adjoining isobars, say, for 29·60 and 29·70, gives the barometric gradient. When the isobars are straight the wind velocity, which is supposed to blow parallel to the isobars, and is called the "gradient wind," is easily calculated, and is strictly proportional to the gradient. If the isobars are not straight, but curved, it is still possible to calculate the value. I believe the formula for this purpose to have been first given by Ferrel, an American meteorologist, who died some 15 years back, and to whose work sufficient credit has hardly been given either here or on the Continent. Lately Mr. E. Gold has tabulated these values in a very convenient form for the use of the Meteorological Office (M.O. No. 190).

When the formula was first given by Ferrel, it was soon found that actual values of the velocity of the wind taken from the records of anemometers did not agree with the theoretical values, but were much smaller. But of late years a large number of observations of the wind have been made at altitudes up to 6,000 ft. and more by kites, and in England and the Continent by means of pilot balloons, this last method having been employed extensively by Mr. Cave at Ditcham Park, Petersfield. It is now found from these observations that on the average the velocity of the wind obtained by observation at a height of from 1,000 to 4,000 ft. agrees very well indeed with the gradient wind deduced from the weather chart. I would therefore advise anybody who for purposes of aviation requires to know the wind above, to consult the Meteorological Office and to get from them the latest information about the gradient wind, for a barometric chart certainly gives more reliable information than can be obtained from an anemometer at the surface. A study of the weather maps prepared by the Meteorological Office and published daily in some of the newspapers will soon convince anyone of the general dependence of wind on barometric gradient, and it will also show how in the matter of aviation England is handicapped by her weather conditions. The cyclones or depressions that cause strong winds and gales are very much in evidence on the charts, and it will be seen that their usual track is from S.W. to N.E. just off our western coasts. It is seldom that one of any size crosses the Continent, and in consequence there is in general over the Continent what we in England should call a great deficiency of wind. In fact, the windiness of England is a common source of complaint with visitors from abroad.

Wind affects aviation in two ways, firstly by its actual presence, and secondly by its steadiness or gustiness.

The ordinary spherical balloon being absolutely at the mercy of the wind, can only go where the wind takes it. By rising or falling it may get into a current of air blowing from a different point to that of the surface wind, and hence it becomes of importance to know what change of direction and what change of velocity may reasonably be expected in the upper currents. It may be stated at the outset that to foretell the change with certainty is an absolute impossibility, but certain rules that generally hold can be given. Almost every wind that blows at an inland station will be found to be stronger at a few

hundred feet than at the surface. As a general rule it will be found that if you face the surface wind, the wind above will come somewhat from your right hand. Suppose a balloon is at a height of 2,000 ft. An east wind is not likely to increase much in strength above this height, but a south-west or west wind is likely to do so. A south-east wind on the surface is fairly certain to turn to a south, and then to a south-west wind at a moderate elevation, and a north wind may draw into a north-west, but is not so likely to do so. As a rule for winds other than north a change of two points of the compass in direction and a doubling of the velocity may be expected between the surface and 3,000 ft., excepting during a hot sunny day in spring and summer. On such days a general mixing of the air by convection currents tends to equalise the different strata, and the velocity at the surface will not be greatly less than that above. At night calm mostly prevails in the lower strata if the sky be clear, and this is particularly the case on frosty nights, and even days too, in winter. But there is no rule hardly without an exception, and I have met with exceptions to all the above rules.

The above remarks are not deduced from any tabular matter, but are the result of my own observations and experience obtained during some thousand or so kite ascents made during the past eight years.

An airship is not so entirely at the mercy of the wind as a spherical balloon, but it is still far too much at the mercy of the wind. This is particularly the case with regard to starting and landing, and it is probable that no airship could be got into or out of its shed if even a moderate breeze were blowing transversely to the axis of the shed. The situation for these sheds should be very carefully chosen so that there may be as much shelter as possible from the wind. The best shelter is perhaps obtained by a broad belt of tall trees, for there is always good shelter on the lee side of a wood, whereas a valley with steep sides is often a very playground for the winds, and a shallow valley with gentle slopes is but little better than an open plain.

A flying machine is less dependent in one way upon the action of the wind, but it is more so in another. In discussing the action of the wind it is necessary to define very carefully what we mean by wind. I am disposed to class wind under two headings, one which I may call the theoretical or mathematical wind, and the other, which I call simply wind and which is met with in ordinary practice. By the theoretical wind I mean the motion of the air such that every particle of air is moving uniformly, in the same direction, and with the same velocity as its neighbours. Such a wind does not exist in nature, but may be closely approximated to on some occasions by winds in the upper strata, and to a less extent by winds over the open sea. The action of such a wind on a flying machine is to carry it in its own direction and thereby to alter immensely the time required to go from one place to another, but such a wind, no matter at what speed it may be blowing, will not have the slightest effect upon the stability of the machine when it has once left the ground. It would, indeed, if its velocity were about the same as that of the machine, render starting and landing easy, but otherwise the airman, if owing to darkness or clouds, he could not see the earth, would be totally unconscious of its existence. I know that this must be a hard saying to those without mathematical training and who have not had to study problems involving relative motion.

Although this theoretical wind does not exist in nature, it is a thing of daily occurrence by artificial means, and is met with by every passenger in a railway carriage or cabin in a steamer. In such cases, assuming the windows shut, all the air particles are travelling uniformly and the traveller is quite unconscious of their motion. A fly, flying about in the carriage, is equally unconscious, and is in exactly the same position as the flying machine in the hypothetical wind. On the steamer the passenger may go on deck, and if it chances that the steamer is a very fast one and there is a strong wind from directly behind, he will hardly be conscious of any wind, excepting from the roughness of the sea.

But the real wind is very different, particularly at inland stations and on certain days. No two air particles appear to be moving with the same velocity or in the same direction, and any light article exposed to the wind is carried first to one side, then to the other; first up, then down. Two anemometers have been placed side by side some eight feet apart, and it has been found that the wind velocity at the head of one may for a second or two be double that at the other. It is this sort of wind that is fatal to any

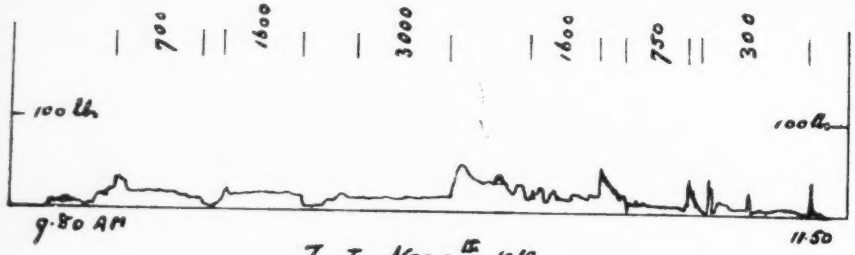


Fig I Nov 9th 1910

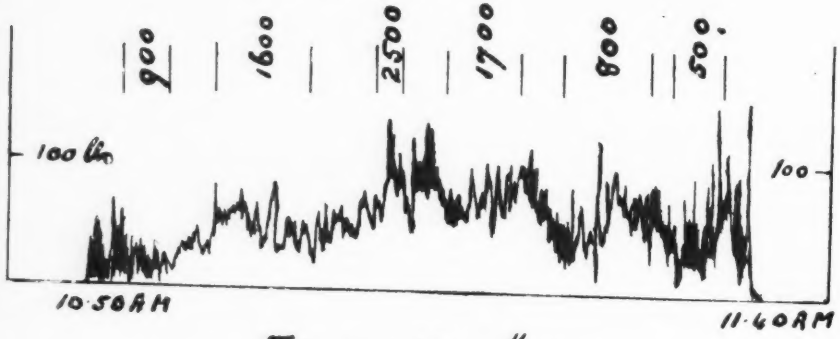


Fig. II Nov 11th 1910

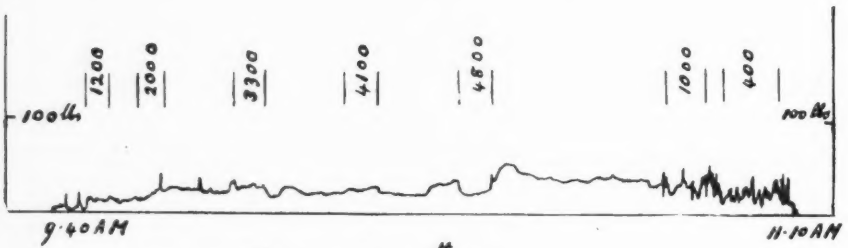


Fig III Nov 14th 1910

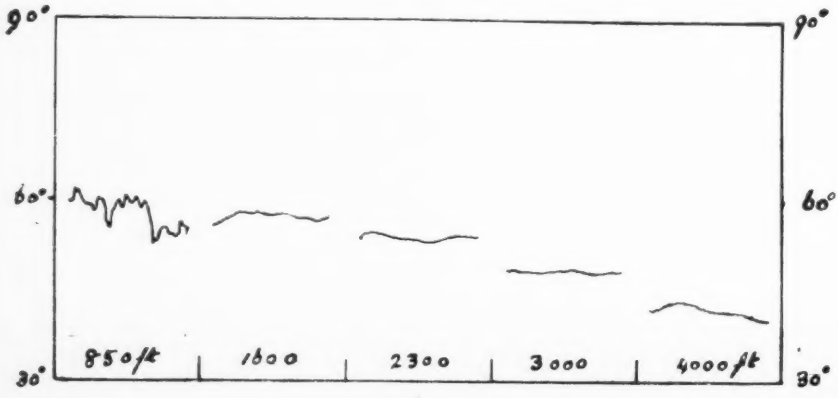


Fig VIII

aeroplane, but it is this sort of wind that has to be encountered. Of course, so long as the wind is light, the variations in its strength are trifling and unimportant, but light winds and strong winds seem to be subject to the same percentage variation in velocity and with a strong wind the actual variations are large.

It seems to me that progress in the art of mechanical flight depends largely upon meeting and overcoming this difficulty of the gustiness of the wind, and the first point is to know precisely what has to be met. It has been my business to fly kites at all seasons and in all kinds of weather for many years for the purpose of obtaining observations for the Meteorological Office, and during the process the irregularities of the wind have been impressed upon me by much unpleasant experience, still I hope that some information has been obtained that may be of use. Some seven years ago I attached to my apparatus a clock and drum on which the tension of the wire holding the kite was automatically recorded, and the arrangement has been in regular use ever since. Figs. I. to IV. are copies of some of these traces, and show that connection between the pull exerted by the kite and the height of the kite at the time.

In Figs. I. to IV. the base line shows the time, and the height above the base line shows the tension of the wire. The figures written above show the average height in feet of the kite above the ground, the amount of wire out remaining constant for the space between the two vertical lines between which the figures are written. In Figs. I., III. and IV. the effect of letting out or pulling in the wire on the tension is plainly shown; in Fig. IV. the wind velocity was so great that the letting the wire in or out had little effect and hardly shows. In V. and VI. the time scale is vertical, and the parts where the kite was being let out or drawn in are omitted. This remark also holds for Figs. VII. and VIII., but in these the time scale is horizontal and the vertical scale shows the angular elevation of the kite.

In general the pull becomes much steadier as the kite rises, and this for two reasons: firstly, with an exception to be presently noted, the wind becomes much steadier with increasing height; secondly, with more wire out an efficient spring is provided by the stretching and the sag of the wire. But I have reason to think that the smoother curve is but slightly due to the spring of the long wire. The exception mentioned is the strata where small curling and fleecy clouds are being formed. At whatever height these special clouds are found, at that height the tension of the wire is always jerky, notwithstanding its capabilities as a spring, hence it seems likely that the spring of the wire will not in any case suffice to smooth down the curve unless the wind be steady. In bad weather at Pyrton Hill a small kite of 44 sq. ft. sail area is used. It is said that if a kite can be got safely through the gusty surface wind it will fly safely in the steadier wind above, but such is not our experience. We find that the chance of a kite being broken or diving is under average conditions about equal at all heights up to 3,000 ft. With a different type of kite it is quite likely that a different conclusion might be reached. The wind near the surface is far more gusty, but the wind above is far stronger, and the two matters seem to about balance each other. From the automatic traces it appears that the maximum pull on the wire, and it is on this that a breakaway depends, is about the same at all heights.

This is notably the case with Fig. II. This diagram was taken on Nov. 11, and the wind velocity at the highest point was shown by the anemometer attached to the kite to be 50 miles an hour. Fifty miles an hour corresponds to force 9 on the Beaufort scale, a strong gale, and although common enough on the coast, or at least on the western coasts, it is very seldom experienced inland in the south-east of England. In fact at Kew in some years even force 8 is not reached. Anyway it is certain that the kite and wire that gave the diagram if sent up in a surface wind represented by force 9 could not have survived five minutes, yet the kite flew quite steadily and well in this wind at a height of about 2,500 ft. This appears to afford conclusive evidence of the steadiness of the upper wind compared with that of the lower, for the change of density at 2,500 ft. is unimportant. The other diagrams were taken with a larger kite on fairly calm days. Fig. I. at the highest level shows a very good approximation to the theoretical wind previously mentioned.

Figs. V. and VI. show the same increase of steadiness with height, but are obtained in a different way. These are copied from a diagram obtained from a theodolite. The theodolite is kept pointing to the kite, and the diagrams show the change in the direction of the wind from minute to minute at various heights. They show also the change as the height increases. That shown in Fig. VI. is peculiar, the sudden veering at a small height and then steady backing of the wind as the height increases is not at all what might be expected. Figs. VII. and VIII. show changes in altitude, they represent the angular elevation of the kite, but they do not necessarily show any upwards and downward motion in the atmosphere, for the changes, such as they are, may certainly be produced by changes in the horizontal velocity.

It is, however, perfectly certain that vertical currents exist. The ordinary angle of our kites in a good steady breeze is between 60° and 65°, but it is quite common to get angles well over 70° for a short time. Also at times a kite may fly almost overhead with quite a slack wire. This may last for a minute or more, and can only be produced by an air current with a vertical component strong enough to lift the weight of the kite.

I think the evidence and considerations given above should be sufficient to convince you that a steady uniform wind will give no difficulty to the management of a flying machine excepting as an obstacle to flying in a certain direction, but that the danger produced by wind is solely due to the irregularity of the wind; and the question at the present time is how this can be met.

It certainly cannot be met by any mathematical analysis which might show how to build an aeroplane of a stable form, for the problem is hardly solvable for the case of a dead calm, and a perfect fluid, and is at present quite beyond the range of mathematics when the air is taken to be a viscous fluid and subject to turbulent motion.

The solution must come from the practical and experimental side, but how?

A very similar problem has confronted the kite flyer, and I think I may say it has been partially solved.

Still the cases are widely different, for the kite flier in case of an accident loses his apparatus, but that is a very different thing to losing his life. My ideal has long been to obtain a kite that could be taken out in any weather except calms and light winds, sent up to a height of at least 3000 ft. with a meteorograph inside, and then drawn back to its starting point with reasonable certainty, with such certainty that is as a passenger to France may have of finding a boat to take him safely from Dover to Calais. No one knows better than I that this ideal has not been realised, we can perhaps send up a kite and meteorograph to 3000 ft. in any weather, but the getting back is not so certain. Still, since January, 1908, about 300 kite ascents have been made at Pyrton Hill, mostly in the winter and mostly to heights exceeding 3000 ft., and twice only have we failed to bring back the kite undamaged to the starting point. This result has not been secured by omitting days of strong wind, for very few days have been omitted on account of such winds. Years back we expected an accident about once a month, and our expectations were seldom disappointed. The improvement has been due to gradual modification and improvement in the details of the kites. The parts that used to break have been made stronger, and other parts where experience showed that less strength was required have been lightened, so as not to increase the total weight. The process was necessarily slow, because when a kite broke in the air and then dived to the ground, it was hard to know which part of the general wreck was responsible for the dive. Our present kite is almost identical with the old ones in shape and size, but some important modifications have been made. The edges of the bad weather kite have been made circular instead of straight. It is probable that the rectangular shape is the more stable but the straight edge is liable to turn over, and the curved edge cannot do so. Powerful springs have been introduced into the bamboo struts that extend the kites and these springs have greatly increased the general reliability, the material is now stretched with a nearly uniform degree of tension, no matter how the hygrometric state of the air may change, also the elasticity of the springs affords a good protection against damage by sudden gusts of wind. The two bamboos are not now lashed together where they cross each other, but the long one slides through a ring fixed on the short one. The ring prevents the long bamboo sagging and giving way under the thrust, and since the bamboo can move longitudinally, there is perfect uniformity in the tension of the material on the two sides of the kite.

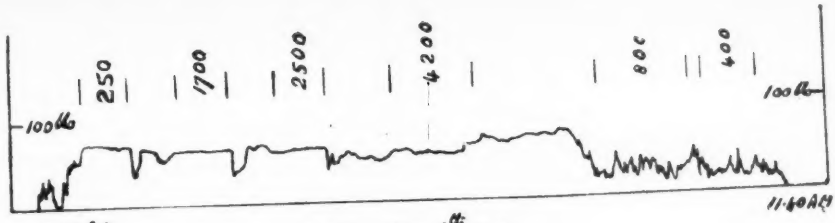


Fig III Nov 16th 1910

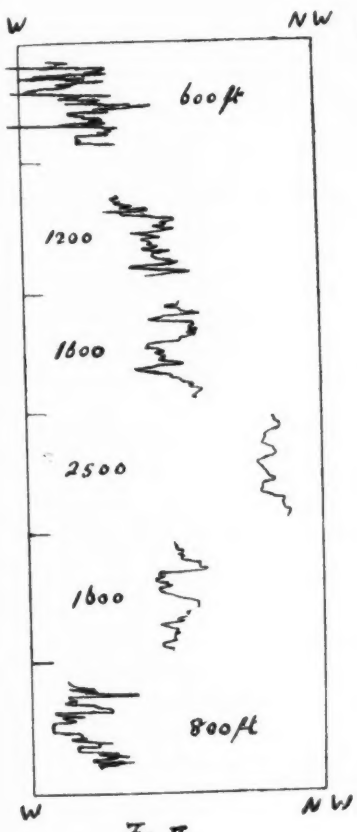


Fig V

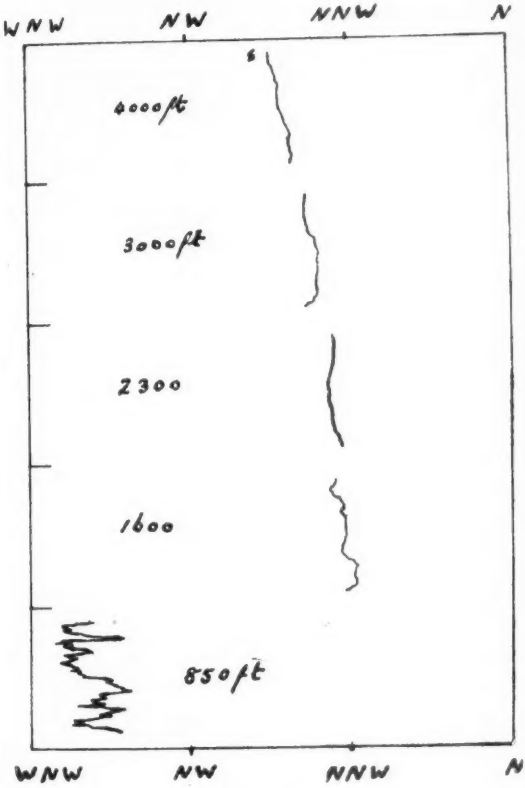


Fig VI

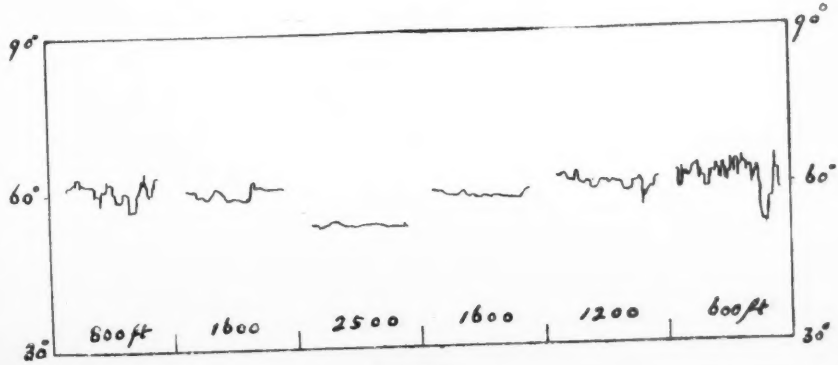


Fig VII

Mr. Lanchester has shown from the theoretical side that for stability an aeroplane should have a small moment of inertia, and this is certainly requisite for a good kite. The points to be attended to are firstly a stable shape, then ample strength in every part to meet the strain that may come upon it, perfect symmetry, and a small moment of inertia. The second and fourth requirements are mutually opposed to each other, and perfect symmetry is in practice very difficult to obtain.

The requirements for a good aeroplane are doubtless very similar, but I must say that the shape of all the machines that I have seen appears to me to be the very reverse of stable.

Numerous accidents have occurred with flying machines. It is inevitable that accidents should occur, and all honour is due to those who are willing to take the risks. Still one cannot help feeling that the long death-roll is partly due to the spectacular and commercial element that has been so prominent. The weather conditions in England being what they are the chance of obtaining suitable weather for an aviation meeting on fixed dates is small unless perhaps the time were fixed for 7 p.m. to 7 a.m. during the summer nights. There are plenty of calm days in England, but their occurrence cannot be foretold.

I should like to add a few words on another point. It is said from theoretical considerations that great speed conduces to stability. Could aeroplanes be made of boiler-plate this might be true, but in practice I believe that the exact opposite is true, and I, should like to see prizes given for the lowest instead of for the fastest speed. When progress has been made and it is easy to land and start in any moderate sized open space it will be time enough to increase the speed, and then it will be easy enough to do so.

DISCUSSION

A Visitor : I would like to know if in suddenly going from one stratum to another we get the same effect as by coming at the end of the tow line. I have a diagram in front of me, and wherever there is a great change of wind or altitude or temperature we seem to have these great variations.

Mr. W. H. Dines : The variations shown there are variations of differences in height chiefly.

A Visitor : I wanted to know if you get any variations of pulling on the rope.

Mr. W. H. Dines : Yes, you get considerable variations in pull on the wire.

A Visitor : I was watching Paulhan when he passed over my house ; he had just got into a valley—I was standing underneath him—and instead of going straight with the wind, he had to turn round slightly and dive into the wind. He was then able to go a short distance, and got into the course he wanted, and went straight along. He was going from one stratum into another. He suddenly came into a valley. I was wondering whether the sudden change from one stratum to another accounts for some of the peaks we see in your diagram.

Mr. W. H. Dines : Not as a rule, I should say. There are sometimes sudden changes of wind velocity, but it is not a general rule.

A Visitor : I am not talking about the action of wind, I am talking of suddenly going from one stratum into a lower one. Paulhan's machine dropped twenty feet in the air. He lost his seat.

Dr. Shaw : There must be some difference of wind in the two strata. You speak of two strata as though you could put a label on one stratum.

A Visitor : You might meet a downward wind in going from one stratum which pushes the aeroplane right down.

Dr. Shaw : You might not find it twenty feet below.

A Visitor : Will you find it on the earth ? I will give you an instance. Going around Brooklands there is a great slope which the wind catches, and it goes right round in the same way as a wave breaking on the shore. But I do not know whether that happens in the higher strata, though I should think not. What is most dangerous to a man flying is these sudden changes and sudden gusts of wind.

Dr. SHAW: I take it, it would be a turbulent motion.

Mr. W. H. DINES: There are variations in wind-direction up and down, or sideways, and they are particularly prevalent near the surface. You do not get so much or so many of them higher up.

Mr. W. F. REID: We all wish to express our gratitude to Mr. Dines for having given us so excellent a paper. Aeronauts go up into the atmosphere, but they know very little about it, as a matter of actual practice. A professional aeronaut or flying man only thinks of the immediate wind that happens to be striking the machine. With regard to these local currents, I suppose Mr. Dines will call anything up to 500 feet near the surface of the earth, and practically it is between 500 and 600 feet, as I understand by the diagrams, that these changes take place. I think they are to a great extent due to the heating of certain surfaces of the earth, as Mr. Dines has correctly pointed out; but sometimes you can observe them very plainly in mountainous regions. It is one of the chief difficulties in trying to traverse the Alps by balloon or aeroplane, that these currents are continually rising and going in quite different directions. You cannot see them with the eye on many occasions, though sometimes you can. About six weeks ago I was in a valley about a mile wide, the wind was rising up the mountain on both sides, one in the east and the other in the west, and there was a wind going both ways; evidently, the air was coming down in the centre, although it was most calm in the valley. But there was a wind, as you could see by the mists being blown away by the side of the snow-clad mountains; you could see that a wind was going in two opposite directions. It was clearly a local current. Again, these currents are produced artificially. We had a very interesting case at Brussels not long ago, when the great fire took place at the Exhibition there. It started with the wind from one direction at the time that the fire began, and then providentially, as the people said, the wind changed. Really it was the fire that made the wind change. The enormous mass of heated air going upwards naturally drew in the air from the sides, and as long as the velocity of that air drawn in was not greater than the wind that had started the progress of the fire, there was no change; but when the velocity of the in-drawn air got greater, then the wind changed. But those things are not usually put down to natural phenomena; they are generally attributed to some intervention of somebody or other, and in Brussels they had a plaster cast of Saint Michel, the patron Saint, which was not burnt but stood there among the wreckage. I have a photograph of him. They said he had changed the wind, and had escaped the fire. That is all very nice, but he happened to be made of plaster and plaster won't burn, and so he didn't burn.

With regard to the interesting diagrams that Mr. Dines has shown us, I would like to ask him whether he thinks that the great length of wire hanging on the kite may steady it to some extent. There is a certain amount of elasticity in a pendant wire of such great length, and it might possibly affect the gradients at such a high altitude. Then, with regard to the question of thin fabric and thick fabric on a kite, is it not to some extent due to the air going through the fabric? Again, have experiments been made with kites of inflammable tissues, with thin dress tissues and with thick dress tissues, because, in experiments I have made myself, I have found a slight permeable fabric has a better bearing on the atmosphere than one of the same area that is quite impermeable. I attribute that partly to the fact that it is continually coming in contact with what we call live air. It is a matter of very great importance in this particular branch, and I have no doubt Mr. Dines has information on this.

Dr. SHAW: Before asking you to give a vote of thanks to Mr. Dines for his most interesting lecture, I should like to say that to me, personally, the lecture has been a very great pleasure. The diagrams that Mr. Dines showed are, so far as I know, an entirely new contribution to our knowledge of the atmosphere. Nothing of the kind has ever been shown, so far as I know, upon a screen before. The practical application of weather to aeronautics is, I suppose, known to everybody; and the experience is painful indeed. It is the application of meteorology to aeronautics on which we depend, to a certain extent at any rate, to avoid the unpleasant application of weather to aeronautics. The question of the gustiness of the wind at different levels is one of very

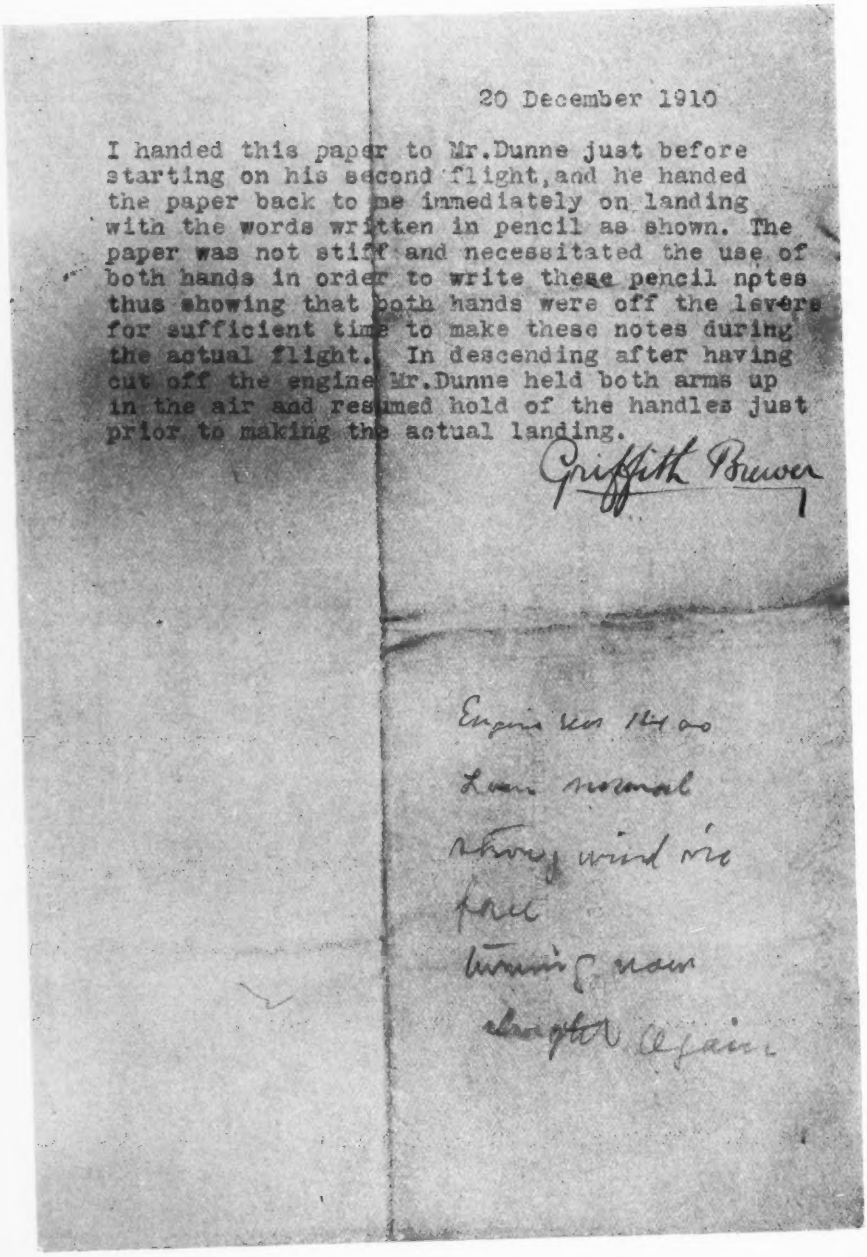
great interest, and one to which I paid much attention in a recently published memorandum about the wind-structure that contrasted the gustiness at different stations in different parts of the country. That raises the question which was mentioned a little while ago as to the wind, and its affect upon the aeroplane in passing from one stratum to another. We meteorologists are accustomed to regard going from one stratum to another stratum as a serious movement of a considerable vertical distance in the atmosphere generally, and we find so far as ordinary wind is concerned, which we should measure on an anemometer, that the transition of one stratum to another, where the character of the wind is different, is, generally speaking, quite gradual. If one wants to get the direction of the wind reversed, one has to pass through a stratum where the direction of the wind is practically zero, and then it begins again in another direction. There are, however, occasions on which one passes from one stratum to another where the wind gradually changes its direction, and may increase in force gradually as one goes upwards, so that as one gets upwards the wind changes the point of the compass by which it comes, and gradually increases in intensity. As one goes up, so one goes through a gradual process of turning the weather-cock, and at the same time increasing the force of the wind. In examining the structure of the atmosphere, there are indeed almost all conceivable instances brought to light. In passing from a stratum where the wind is blowing strongly in one direction to a stratum where it is blowing strongly in a different direction, the transition is gradual either as regards velocity or as regards direction. Mr. Dines has not mentioned what I think would be found, and what indeed is found for aeronauts a very valuable addition to their equipment, and which is now of great use in meteorology, and that is the pilot balloon. He has dealt almost exclusively with kites and unmanned balloons, but balloons carrying instruments he has not dealt with. It is now the practice of meteorologists to follow pilot balloons with theodolites in order to ascertain the direction and velocity of the wind at different points in that course. The result is a very large addition to our knowledge of the curious criss-cross of currents that one finds in the atmosphere. It is upon experiments of that kind that I rely when I say that the transition from one stratum to the other is generally speaking gradual. But the gustiness that one speaks of is another curious phenomenon about which we know very little. If you get a record of the direction and velocity of the wind near the surface, when the wind is blowing with any considerable velocity, say 30 miles an hour, you will notice constant fluctuations in velocity. Now these fluctuations may be related in the same way as if the air were turning over billow-fashion. We should call that a case of turbulent motion and rather distinct from the average velocity of the wind which occurs apart from influences. But when one comes to the turbulent motion, the motion which may be caused by the wind having to pass obstacles such as a fence or a house or something of that sort, there is no doubt that there must be much turbulent motion introduced into the atmosphere by the passage of the air currents past obstacles, and in consequence the air must be full of all sorts of complicated motions which are not very extensive in area and very transitory, but which I presume for an airman may be extremely important. That is a part of the subject that is at present only beginning to be investigated, and we hope in course of time to be able to throw some light upon that also. Mr. Dines carried us, in the earlier part of his lecture, to regions of the atmosphere in which meteorologists must be at present more interested than aeronauts, and to that delightful region where no further fall of temperature takes place. It is a far cry for anyone who would get there in a flying-machine as the pressure there is about a fifth to a tenth of the pressure of the atmosphere. But all this information tends in course of time to extend our knowledge of the general structure and leads us to find out the secrets upon which to a certain extent the stability of these machines depends. There is one point that occurred to me about Mr. Dines' illustrations, going back to this question of gustiness which I have said is very attractive and important, and that is the question of the variation in the altitude of the kite as watched by a theodolite. Mr. Dines pointed out that the greater the height of a kite the less were the variations noted. I presume that may be accounted for by the greater length of wire due to the greater distance of the kite. I suggest that possibly the same variation in the height of the kite at the greater distance would show less on the theodolite angle if the distance of the

kite were greater than it would be if closer. But perhaps, considering the greater length of wire out, the fluctuation in the strength of the wind ought to make a greater difference in the altitude; perhaps this explains the reason why Mr. Dines did not call attention to the effect of distance upon the measure of the variation of altitude.

The whole subject is of very great interest, not only to meteorologists, but to aeronauts, and this study of the structure of the wind takes us into a new region. In regard to the application of meteorology to aeronautics, slightly touched upon by Mr. Dines, I will put it in this bald way. If a man goes up in a balloon in, say, a south-westerly wind, where will he ultimately come to? Will he go on travelling south-west for ever and ever, until he comes back again round the other side of the earth, or will his south-westerly wind convert itself into a northerly wind, and if so, will he come back in a circle smaller than the complete circle of the earth? If not, try an easterly wind and try a westerly wind and consider where, if you go on long enough, you will get to? That problem attracted the aeronauts in connection with the "Daily Graphic" for some considerable time, and they were extremely anxious to know where wind of certain directions would take them to. They desired to send a balloon further than anybody had sent one before, and they wanted to know the sort of wind that would carry a long way on a perfectly definite course, so that they might come to land at the end. For purely meteorological reasons we have paid a good deal of attention to the ultimate destination of a balloon that floats in the atmosphere when we know the direction and particularly the barometric distribution at the surface. These are points that lend themselves very readily to discussion, and I ask Mr. Dines to reply to the points which have been suggested; then I will ask you to give a very hearty vote of thanks to Mr. Dines for coming here and giving us this most interesting lecture.

Mr. W. H. Dines: In regard to the length of wire, the greater sag and spring of the wire must have a considerable effect, but I do not think that effect is comparatively large, and for this reason: In looking over this paper I missed a point that I intended to mention to you, but did not. There is a certain exception to the steadiness of the wind, and that is when certain cloud level is reached. The particular level at which those racy small curling fleecy clouds float is always a gusty level, and if I had one of those charts it would show that, though a considerable amount of wire was out, there was the ordinary spring and sag. With reference to light material being more pervious, undoubtedly it is more pervious, and the result of wetting that material decidedly increases the angle at which it flies. I have tried calico, but with heavy calico a kite will not fly well.

Dr. Shaw: May I express your thanks to Mr. Dines for the interesting lecture and congratulate him on the success that he has achieved in the development by small changes from the original form of his kite to the one which he has here so greatly improved; and also upon the other advances he has made in the study of the atmosphere to the advantage not only of meteorology but of aeronautics.



20 December 1910

I handed this paper to Mr.Dunne just before starting on his second flight, and he handed the paper back to me immediately on landing with the words written in pencil as shown. The paper was not stiff and necessitated the use of both hands in order to write these pencil notes thus showing that both hands were off the levers for sufficient time to make these notes during the actual flight. In descending after having cut off the engine Mr.Dunne held both arms up in the air and resumed hold of the handles just prior to making the actual landing.

Griffith Brewer

Engine revs 1400
Lever normal
Rough wind nil
force
turning rear
skeg left again

FACSIMILE OF WRITING TEST

THE DUNNE BIPLANE

REPORT ON AUTOMATIC STABILITY TRIALS

Mr. Griffith Brewer and Mr. Orville Wright have jointly observed, on behalf of the Aëronautical Society, the trials made by Lieut. J. W. Dunne for the purpose of demonstrating the automatic stability of his biplane. The flights were made at Eastchurch, Isle of Sheppey, on December 20th, 1910.

OFFICIAL REPORT

21st December, 1910

Yesterday afternoon we observed two flights by Mr. Dunne on his automatic stability machine, at the Royal Aero Club ground at Eastchurch.

The first flight was over a distance of about three miles (not timed) the machine being turned at a height of about 100 feet and making a good landing near the starting point. On the second flight of 2 minutes, 29 seconds, Mr. Dunne made notes on a piece of paper during the flight. On both flights the engine was cut off in the air before landing and the machine came down without materially altering its angle of incidence.

Orville Wright,
Griffith Brewer,
Members of the Aëronautical Society

WRITING TEST

20th December, 1910

I handed this paper (reproduced in facsimile facing this page) to Mr. Dunne just before starting on his second flight, and he handed the paper back to me immediately on landing with the words written in pencil as shown. The paper was not stiff and necessitated the use of both hands in order to write these pencil notes thus showing that both hands were off the levers for sufficient time to make these notes during the actual flight. In descending after having cut off the engine Mr. Dunne held both arms up in the air and resumed hold of the handles just prior to making the actual landing.

Griffith Brewer

[Notes made in pencil by Mr. J. W. Dunne.]

Engine revs. 1400
Levers normal
Strong wind in face
Turning now
Straight again

ACCOUNT OF THE TRIALS

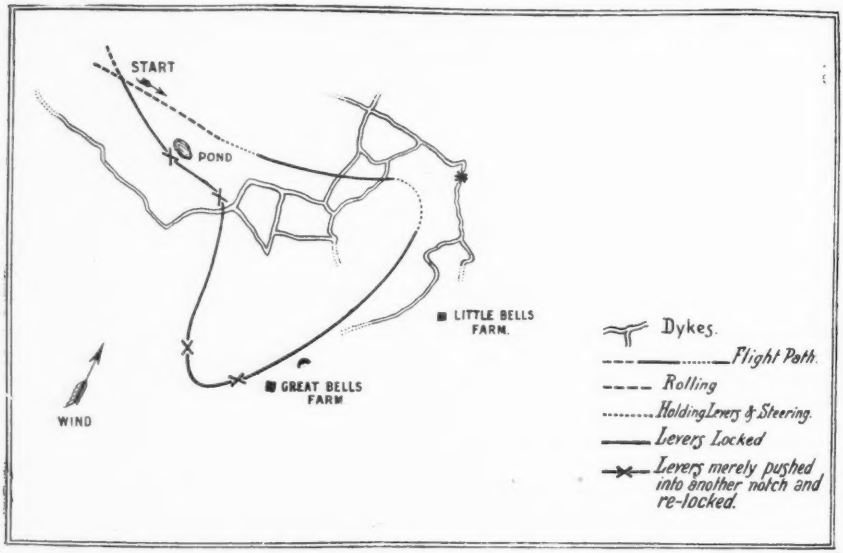
BY J. W. DUNNE

As Mr. Orville Wright and Mr. Griffith Brewer were both pressed for time I decided to make only short circular flights.

Obviously, the first thing to do was to show that the machine could fly as well and as strongly as those of the ordinary T shape, to exhibit the power of control and manœuvre given by the two little steering flaps, and above all to show that with this type of machine good turns, with the correct amount of banking, and no slide-slipping, could be effected without resource to the complicated "three-rudder" system. I, therefore, contented myself with a closed circuit, allowing the machine to climb 100 feet on the turn, and as this was the first time I had turned at any height, I confined my attention to making a neat job of it, and made no particular attempt to show off the automatic stability of the machine, until it came to descending. It is a well-known rule of flying that, before throttling the engine, the machine's bow should be pointed slightly downwards to avoid the

loss of speed that would otherwise ensue, and it is in the proper manipulation of the levers immediately afterwards, to maintain speed and keep the machine under control, that the trained aviator has to exercise his greatest skill. To throttle *without first depressing the bow*, and then leave the machine severely alone, is a stiff test of longitudinal automatic stability though, of course, no test of lateral stability. So both in this flight and in the second, I first locked the levers in the central position in which they are left while flying, then throttled, and immediately threw up my arms and left the machine to come down from the flying tilt to the gliding tilt of its own accord, and thence find its way earthward. The steep slope of the ground at the point of landing rendered it unsafe to attempt the requisite flattening of the trajectory before touching earth by the use of the throttle alone, so at the last moment I utilised the flap-controls for this purpose.

The next point was to prove the safety of the machine. As we have no place for passengers in the present apparatus I suggested that I should go round the same short circuit and carry out the writing test. I proposed this, as I know of nothing else which so thoroughly puts to the proof the aviator's real trust in his machine's fitness to look



after itself, compelling, as it does, absolute detachment of the mind. One may eat, drink, smoke, click a camera, take off one's coat, or do a hundred other things, and all the time keep one eye ahead to see what the machine is really doing, and be ready to snatch at a lever if necessary. But when writing, sitting low in our big boat, one's attention is perforce completely withdrawn from one's surroundings. I ran down across the wind, hopped off, touched again, and then began to rise steadily. As soon as I saw that I would clear the bushes on the boundary dyke, I locked the levers, and felt for the paper and pencil given me by Mr. Griffith Brewer. The paper was in one pocket and the pencil in another; by the time I had got them ready I must have flown a considerable way. I started to set down certain points I was anxious to observe and remember. First, I counted the divisions on the revolution indicator, which has no figures between the 1,000 and 1,500 marks. When I began to set them down I found that unfortunately it was almost impossible to write on the thin paper with only the fingers and palm of my hand as a backing thereto, and that a certain amount of excitement rendered the task still more difficult. I then observed the positions of the levers relatively to their toothed racks and made a note of that. I next looked about inside

the boat for something else to note, and while doing so became aware of the violent wind in my face, which curiously enough I had entirely failed to notice on the previous flight. As I had been anxious to ascertain how far the front screen shielded the aviator I wrote this fact down. From the time I had first locked the levers, till now I had not paid the smallest attention to what the machine was doing or where it was going. It had been left to follow its own fancy, and might by this time be anywhere or in any position for all I knew. However, looking up I saw that it was still level, but had drifted down wind and was aiming to hit a wind-pump, so I decided to commence the turn.

I separated the levers, holding them till the turn had started, noted its radius, which was shorter than I required, diminished the difference between the lever positions, locked them, waited a little time, hands off, until I was satisfied with the radius of the turn and with the rapidity with which the machine was mounting, got hold of my paper again and with some difficulty wrote "turning now." Looking over the port-bow I saw a farm-house nearly beneath me, and realising that the circle was now bigger than I had intended, and also that I was much higher than I had thought, I pushed each lever into the fourth notch, and, sitting with my hands in my lap, allowed the machine to swing itself sharply round. Then I locked the levers centrally and sat back, but did not continue writing as I was puzzled by a momentary failure to recognise the ground below me. I am not a balloonist, and am unused to heights. After a moment I realised that a little dark green blob was the pond in the middle of the ground. So I turned the machine towards it, and then wrote "straight again." By the time I had got that down I saw I should have to descend at once if I meant to get back to my starting point, so I moved the machine's nose a degree or two round, aiming at the point in question, returned each lever carefully to its central notch, throttled the engine, and held up my arms. Instantly the machine's head drooped a little, and, without any abatement of forward speed, she began to sink towards the ground. I landed her as before described.

ACCIDENT

On December 22nd, 1910, the machine, piloted by Mr. D. W. A. Barton, met with an accident while landing. This mishap must be ascribed to a false movement of the pilot at the moment of touching the ground, and, as will be obvious from the following reports by independent eye-witnesses, in no way affects the qualities of stability possessed by this machine.

On Thursday, 22nd December, I saw Mr. Barton fly Mr. Dunne's aeroplane at the Club Grounds, Eastchurch. On reaching the end of the grounds I saw him come down and make what I thought was a very good landing, but he was turning at the same time to avoid the dyke, and the wing-tip struck the ground before the wheels did, and then the machine turned turtle.

W. Cozens,
Foreman, Royal Aero Club Flying-Ground, Eastchurch.

We saw the accident to Mr. Dunne's machine on the 22nd of December. The machine landed gently, but was turning to the right at the same time; the right wing-tip hit the ground and turned the machine over.

F. Gard,
A. Blatcher,
Employees, Royal Aero Club Flying-Ground.

Mr. Dunne's machine, piloted by Mr. Barton, passed by the end of the Club sheds a few feet off the ground and touched the ground again just in front of the roadway to Bells Farm; but the machine lifted again after running a few yards, keeping straight ahead, gradually dropping. Then, on starting to turn, the wing-tip started to rub on the ground, and the machine looked about longitudinally level with the back wheel off the ground. Suddenly the machine seemed to lock herself, bringing the nose of the machine hard on the ground, turning the machine completely over, carrying away the main planes, finally letting the chassis rest on top of the engine cylinders. At the same time the propellers broke away the girder-work carrying them, and lay flat on their faces. On reaching the machine it could be seen that the front wheels and skid were jammed between the two chassis-wheels. This, I should say, caused the accident.

S. Hamilton,
Mechanic to Professor Huntington.

TECHNICAL WORDS COMMITTEE

MAJOR B. BADEN POWELL (Chairman)

C. H. ALDERSON — J. H. LEDEBOËR (Secretary)

A. E. BERRIMAN — H. W. SYKES

B. G. COOPER — C. C. TURNER

PRELIMINARY REPORT

IN view of the somewhat confused state of aeronautical terminology at present prevailing, a Technical Words Committee was appointed by the Aëronautical Society of Great Britain to draft a list of technical terms relating to aeronautics, and to define their meaning. The work of the Committee has proceeded along systematic lines, and has already resulted in the compilation of a glossary of the more general terms in use. It was decided, therefore, to issue this list forthwith, in the form of a Preliminary Report, as it covers fairly well the technical vocabulary involved in the ordinary course of aeronautical work. In due course, the Committee hope to issue a glossary covering the whole range of aeronautical terminology, but the work of selection and definition is necessarily slow when conscientiously undertaken. The Committee wish to draw attention to the fact that they have aimed at making their definitions of technical terms as simple and commonplace as possible. The definition of ordinary dictionary words that are sometimes used technically has, as far as possible, been avoided, in order to give that latitude of expression so much desired by all writers. In a few cases where certain words are used in contrary senses by different schools of writers—such as "aerodrome" and "airship"—the Committee have been forced to take arbitrary action; it is particularly in respect to the use of such words that the Committee hope to meet with support.

GENERAL TERMS

AERONAUTICS—The entire science of aerial navigation.

AEROSTATICS—The science of buoyancy in air by means of displacement; this is, therefore, the term to be applied to the science of aerostation.

AERODYNAMICS—The science relating to the effects produced by air in motion; this is, therefore, the term to be applied to the science of aviation.

AEROSTATION—That part of aerial navigation dealing with gas-borne or "lighter-than-air" machines.

AVIATION—That part of aerial navigation dealing with dynamically-raised or "heavier-than-air" machines.

AERONAUT—One who practises any branch of aerial navigation.

AVIATOR—One who practises aviation.

PILOT—An aeronaut qualified in aerial navigation.

ENGINEER—In charge of the power-plant.

HELMSMAN—In charge of the steering.

SHED—The use of the term *shed* is recommended instead of *hangar*.

HARBOUR—A natural or artificial shelter.

AERODROME—A ground set apart for flying purposes. The Committee do not recommend this term, but, in view of its somewhat general use, suggest that it should be employed only in the above sense. This suggestion is made without prejudice either to its derivation or to its application in another sense by authors such as Langley, Lanchester and Graham Bell.

DIRIGIBLE—A power-driven balloon.

AIRSHIP—This term having occasionally been used to denote *aeroplane*, the Committee recommend its use only in the sense of *dirigible* in order to avoid confusion.

HELICOPTER—A flying-machine supported by one or more screw propellers rotating on vertical or approximately vertical shafts.

ORNITHOPTER—A "flapping-wing" machine.

FLYING-MACHINE—A generic term denoting machines used in aviation, as distinct from those employed in aerostation.

AEROPLANE—A flying-machine provided with fixed planes supported dynamically by its movement through the air.

This term should *not* be used to denote the planes themselves, but should only apply to the whole machine.

GLIDER—An aeroplane unprovided with motive power.

MULTIPLANE—An aeroplane with two or more main planes overlapping in plan-form.

BIPLANE—An aeroplane with two superposed main planes overlapping in plan-form.

MONOPLANE—An aeroplane with a single main supporting plane, which may consist of a pair of wings outstretched on either side of a central body.

TANDEM, STEPPED—In some cases aeroplanes have more than one pair of wings, which may or may not be on the same level; such planes, if they do not overlap in plan-form, must necessarily be arranged in "tandem"; when not on the same level they are said to be "stepped."

For instance, "an aeroplane having three pairs of wings stepped in tandem."

PRINCIPAL DIMENSIONS

AREA—This term is not a technical definition unless qualified by an adjective, as, for instance, "supporting" or "effective" area.

By area is meant, in the case of planes, the area of the plan-form and is therefore measured in units of double surface. That is to say, both sides or surfaces are counted as one unit of area. Thus, by an area of 500 square feet is implied a surface of twice 500 square feet.

SURFACE—Attention is drawn to the distinction that exists between surface and area. *See* AREA.

WEIGHT—This being a general term, should only be used when qualified by an adjective, such as "net weight."

NET WEIGHT—The weight of the complete machine *exclusive* of variable quantities, such as pilot, fuel, lubricants, &c.

GROSS WEIGHT—The weight of the complete machine *inclusive* of all variable quantities, *i.e.*, pilot, fuel, lubricants, &c.

LOADING—The loading of a machine is its gross weight in pounds divided by the supporting area in square feet.

PRINCIPAL PARTS

PLANE—Any element of area used for dynamic support or control

In pure aerodynamics the term should only be used with a qualifying adjective such as "flat," "curved," or "cambered."

The prefix "aero" is restricted to the complete machine defined as an "aeroplane."

WING—The present use of this term, by analogy with natural flight, denotes each of a pair of planes outstretched on either side of a central body, which wings, if continuous, would form a single plane.

BODY—In flying-machines, the central longitudinal framework to which the planes and organs of control and propulsion are attached.

CARRIAGE—That part of the machine beneath the body intended for its support on land or water.

TAIL—In flying-machines, a plane or group of subsidiary planes, which may include both horizontal and vertical planes, behind the main planes.

ELEVATOR—A movable plane or group of planes for directing and controlling the machine vertically.

RUDDER—A plane or group of planes for guiding a machine to right or left.

BALANCER—In aeroplanes, an organ—usually a plane—for maintaining lateral equilibrium.

THE LAWS OF AIR SCREWS

II.—THE SCREW WITH AXIAL MOTION

BY W. R. TURNBULL, M.E.

THIS paper gives the results of experiments with air-screws having axial motion, the same propellers being tested that were described in the first article (appearing in the AERONAUTICAL JOURNAL for October, 1910): namely, sector-shaped, flat-bladed, true screws having diameters of 1·5, 2, 2·5, 3. and 3·5 feet; also several of 2·5 feet diameter having pitch-coefficients varied from 0·4 to 2·0.

In the light of Langley's experiments with a whirling-table, I firmly believe that accurate results can only be obtained with straight line experiments in still air; so, for the purpose of these experiments, I had a track constructed of 30 inch gauge and over 300 feet long, arranged as shown in the profile sketch (Fig. 1). The part A B, 68 feet long, is curved to obtain the initial speed rapidly and without undue length of track; the remainder, from B to F, was 275 feet long, accurately level and straight. From C to D is 50 ft., and from D to E is 50 ft.; between the points C and E all readings are taken, the portion E to F being simply used to bring the truck gradually to rest. The track from A to E is of iron carefully bonded at the joints to convey electric current from a storage battery; from E to F it is of wood.

Upon this track runs a truck, sketched in Fig. 2; B being the body of the main truck, W, W¹ the main wheels. The axles of these wheels run in radial ball-bearings and are

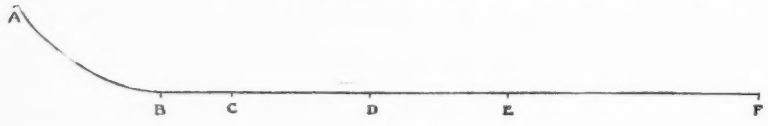


FIG. 1.

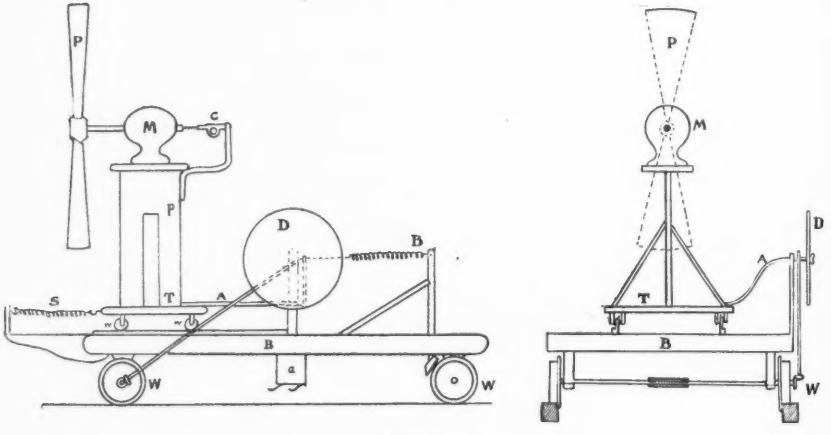


FIG. 2.

insulated in the middle, so that the electric current can be carried from the rails to the motor without the use of brushes or trolley, the whole track being supported by trestle work and each rail being a live rail of different potential.

Upon the body of the main truck there is an auxiliary truck, T, carrying the ¾ HP series motor (described in the first article) mounted on a pedestal, *p*, as shown in Fig. 2.

The auxiliary truck runs on short rails (with guard rails that do not touch the wheels) and imparts motion to the main truck, by means of the spiral spring, S, which has been carefully calibrated. The truck, T, also carries an arm, A, with spring pencil mounted thereon, which records on the disc, D, the amount the spring, S, is extended; in this way the thrust is exactly determined.

The disc, D, carries removable sheets of paper, which are clamped to its inner surface; it is slowly rotated, by mitre and worm gears, from the forward wheels of the main truck, so as to make nearly one revolution for the entire length of the track. Near the outer edge of this disc there is also recorded every 50 revolutions of the motor shaft, and every 50 ft. of track passed over, by electrically operated spring pencils; there being beside the rails, at points C, D, E, (Fig. 1), brass contacts operating one record, and upon the truck, at *c*, a speed-counter operating the other.

Upon one side of the main truck, there is a brake, B, operated by a stiff spring and held from the wheels by a trip-brace. The brake being automatically thrown on at the point E (Fig. 1), where the current is also automatically cut off (by the truck running on to the wooden portion of the rails), the truck then gradually comes to rest.

The motor, M, is mounted on the pedestal, *p* (Fig. 2), and on its shaft is the propeller under test, P, and the speed-counter, c. Although the propellers are carefully balanced there is a slight vibration of the pedestal and of the small truck, T, and this is a very positive advantage, since any friction there may be in the wheels, w, w^1, is quite corrected by this vibration, and we obtain a true reading of the thrust on the disc, D.

In Fig. 2 the electrical connections are not shown, but the motor is connected by wires to the bearings of the main truck; and c is connected by wires to the electro-magnet, recording, by means of a pencil, every 50 revolutions of the motor-shaft on the periphery of the disc, D.

At the points C, D, E (Fig. 1), on the opposite side of the track from those before mentioned, there are other brass contacts leading (electrically) to a chronograph at the laboratory, and when the truck passes these points the arm, *a*, makes a record on the chronograph drum. In this way the speed of the truck between C and D and between D and E is accurately known, and from this speed the number of revolutions per minute of the propeller is computed from the revolutions record on the disc, D (Fig. 2).

This track was completely shielded by a high grove of trees on the southern side, and it was only with light southerly winds, or during calms, that the experiments were made. Even in strong southerly winds the shielding of this grove was almost perfect.

A single experiment is conducted as follows. By trial, the point on the curved portion of the track is found, at which the truck should be released in order that the truck may maintain a uniform speed between the points C, D, and D, E (Fig. 1). When this releasing point is determined the recording disc is placed in position, the chronograph is started, and a run is made, the current by an ammeter being read by an assistant, as the truck passes along the track between the level portion, C and E.

We then have complete data to compute the thrust, r.p.m., brake horse-power and speed of the truck (*i.e.*, the axial speed), and the efficiency of the propeller becomes exactly known, since the thrust multiplied by the axial speed gives the work, in ft.-lbs. per second, that the air-screw is doing on the air; and we have, from the B.HP, the ft.-lbs. per second that the motor is delivering to the propeller.

In the main this machine works admirably, but it is to be regretted that the motor has not sufficient power to maintain an axial speed of more than 25 feet per second (about 17 miles per hour); hence, the curves obtained from these experiments have had to be extended, *by judgment*, to a far greater extent than the writer had wished; nevertheless he hopes that the general results are not far from the truth. The rapid approach of the Canadian winter prevented the installation of a more powerful motor, but possibly next summer more extended results will be obtained.

Due to lack of sufficient time, the results for screws, having different widths of blades, were not completed, and for this reason, and those mentioned above, the writer prefers, at the present time, to make no mention of the modifications, introduced by axial motion, in the stato-rotary laws announced in the first article. But he hopes that the results, published in the accompanying curves, will give a clearer conception of the efficiencies of

air propellers than we have heretofore had, and that they may be of use, in a practical way, to those designing the same. The experiments show that the thrust certainly does decrease from the stato-rotary value, as soon as axial motion commences; and it must reach zero when the ideal case of zero apparent slip is reached. However the actual efficiency increases, as the slip decreases, to a maximum value, as will be seen when we come to examine the curves presented in Plates II. to VII.

It has been stated by some authorities that the efficiency of an air-screw is a constant. This is, on the face of it, an absurdity, and my experiments abundantly prove that the efficiency of an air-screw is a variable, depending on the axial speed, and attains a maximum value, depending on the diameter, pitch co-efficient, etc., at a certain speed, or, in other words, at a certain percentage of apparent slip.

The " thrust-efficiency " (stato-rotary) curve for my propellers is worked out, according to the method of M. Hector Pouleur (see R. W. A. Brewer, " *The Art of Aviation*," pp. 108—111) and shown in Plate I. When this is compared with the actual efficiency curve for these propellers, as shown in Plate III., the absolute unreliability of this stato-rotary method for efficiencies is apparent. The only rational method of determining the actual efficiency of an air-screw is to measure definitely the work put into it, and to measure the work it delivers to its shaft, and find the ratio of the two measurements. I have done this for the sector-shaped screws already described (in the first article), and the results are given in Plates II. to VII. accompanying this paper. The curves are produced to zero, in Plates II., III., V., and VI., for the reason that, at zero per cent. apparent slip, there can be no thrust (*i.e.*, the pitch-speed equals the axial speed, the blades simply cleaving the air); therefore the delivered work is zero and the efficiencies must be zero regardless of the amount of the B.HP.

Before discussing the curves obtained, it may be well to mention that the apparent slip of a screw propeller is obtained from the following formula :—

$$\text{Percentage of apparent slip} = \frac{\text{PR} - \text{V}}{\text{PR}} \times 100$$

in which P is the mean pitch in feet, R is the revolutions per minute, and V the axial speed in feet per minute.

Plate II. gives the results for screws of 2·5 ft. diameter with various pitch-coefficients, the Roman numerals referring to the number of the screw. The full lines represent the portions where measurements were made, the dotted lines the assumed continuation of the same. Only in the case of No. VIII. (pitch-ratio = 0·4) have the measurements passed the points of maximum efficiency, but as explained above, all these curves must reach zero efficiency at zero percentage apparent slip, so the dotted continuations are probably fair approximations of the truth.

Plate III. gives the relation of maximum efficiency and pitch-coefficient, the full line being derived from the results as given for the maxima in Plate II., and the dotted lines being derived from the full line of Plate VI. by taking points at 5 and 10 feet diameter and at pitch-coefficient = 1·0. This gives the points marked × in Plate III., and through these we draw curves similar to the full line. It will be noted that the maximum efficiency lies at pitch-coefficients of 1·25 to 1·5, and that the fine-pitch propellers are distinctly inferior.

Plate IV. gives the percentage of apparent slip at the point of maximum efficiency (abscissae being P ÷ D), the full line being derived from the results of Plate II. and the dotted lines from the full line curve of Plate VII, as previously explained.

Plate V. gives the measured results for screws I. to V., varying in diameter from 1·5 to 3·5 feet, and all with a pitch-coefficient of about 1·0. The full lines represent portions where measurements were made, and the dotted lines the assumed continuation of the same, produced to zero for the reasons given before. The results for numbers IV. and V. (3 and 3·5 feet respectively) were nearly identical, due, doubtless, to experimental errors.

The full line of Plate VI. is derived from the results given in Plate V. and shows the relation of maximum efficiency to diameter. The dotted lines of Plate VI. are derived

Theoretical ("Thrust") Efficiency Curve (according to the method of Brewer)

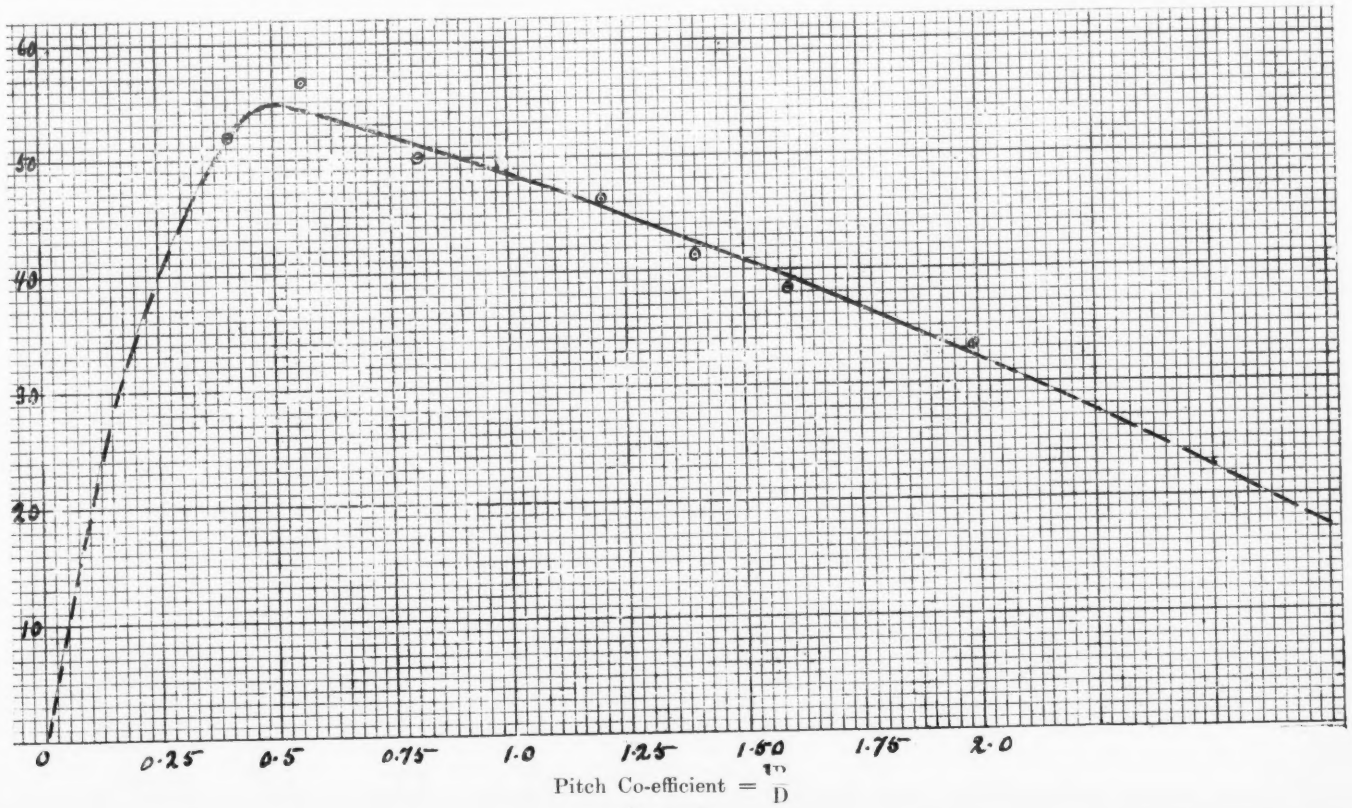


PLATE I

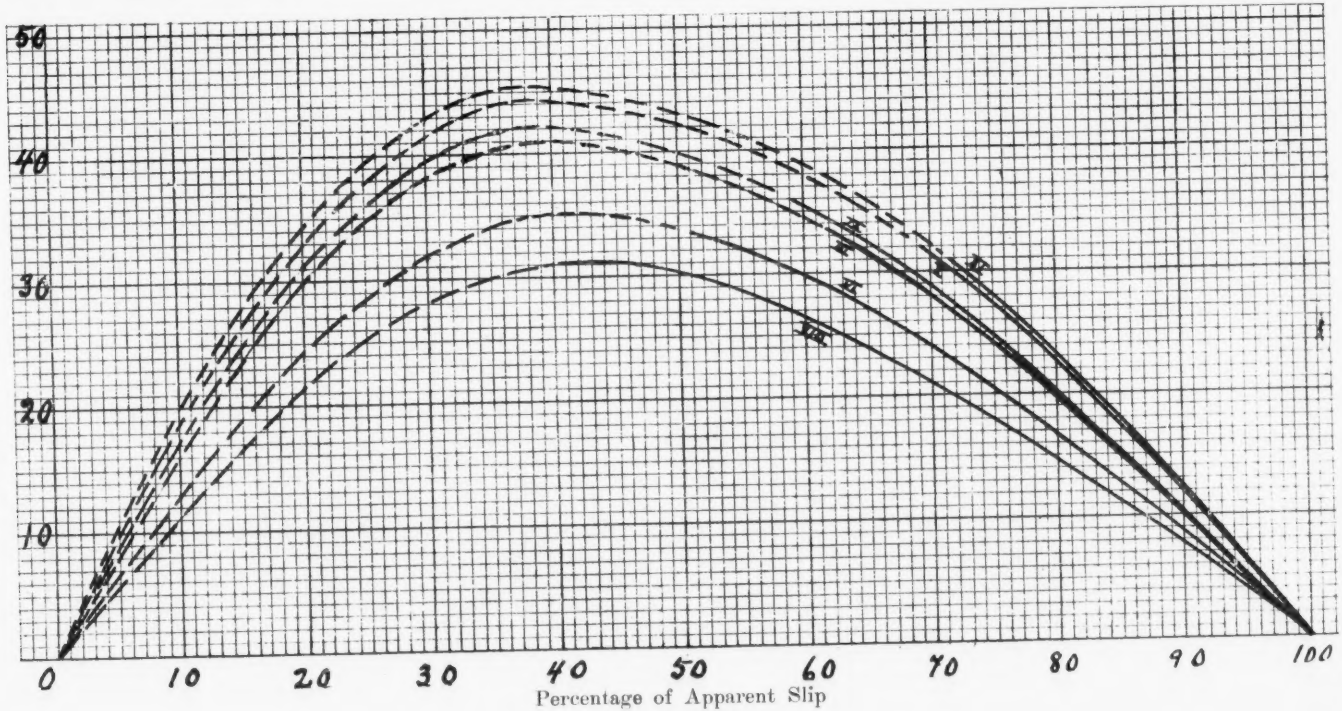


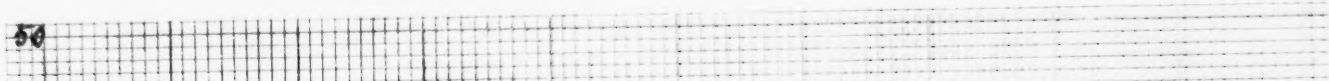
PLATE II

Relation of Maximum Efficiency and Pitch-Coefficient.

Efficiencies of Screws of 2·5 feet diameter and various Pitch-Coefficients

Percentage of Efficiency
0
10
20
30
40
50
Relation of Maximum Efficiency and Pitch Ratio

Efficiencies of Screws of 2·5 feet diameter and various Pitch-Coefficients



Efficiencies of Screws of 2·5 feet diameter and various Pitch-Coefficients

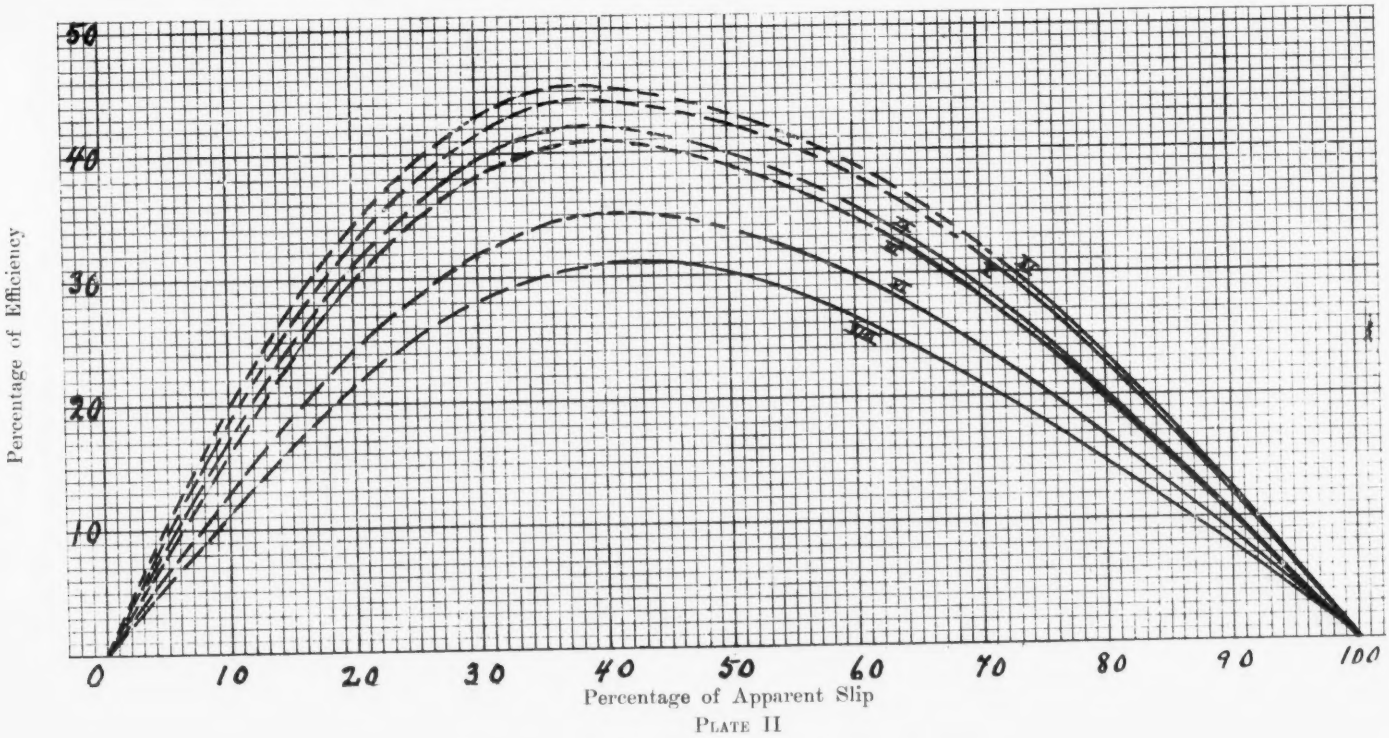


PLATE II

Relation of Maximum Efficiency and Pitch-Coefficient.

Pitch Co-efficient $= \frac{P}{D}$

PLATE I

Efficiencies of Screws of 2·5 feet diameter and various Pitch-Coefficients

0·25 0·50 0·75 1·0 1·25 1·75

P ÷ D = Pitch-Coefficient.

PLATE III

Percentage of Apparent Slip for MaximumEfficiency

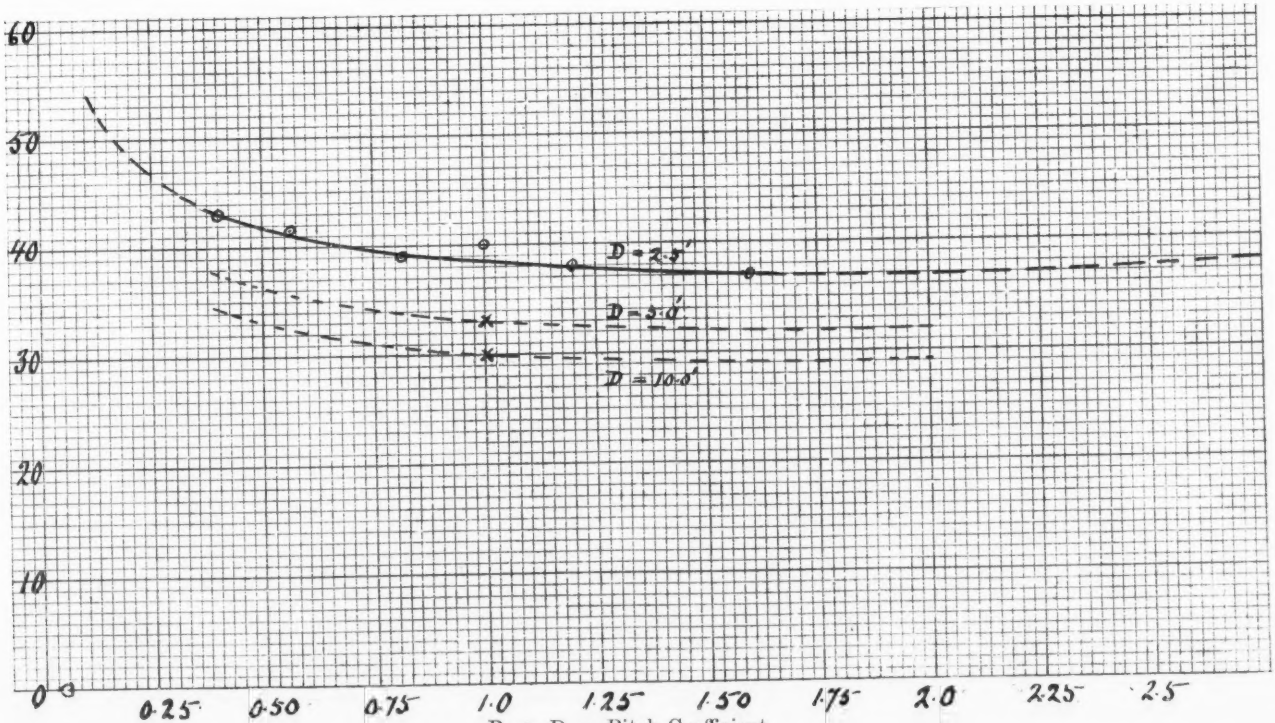


PLATE IV

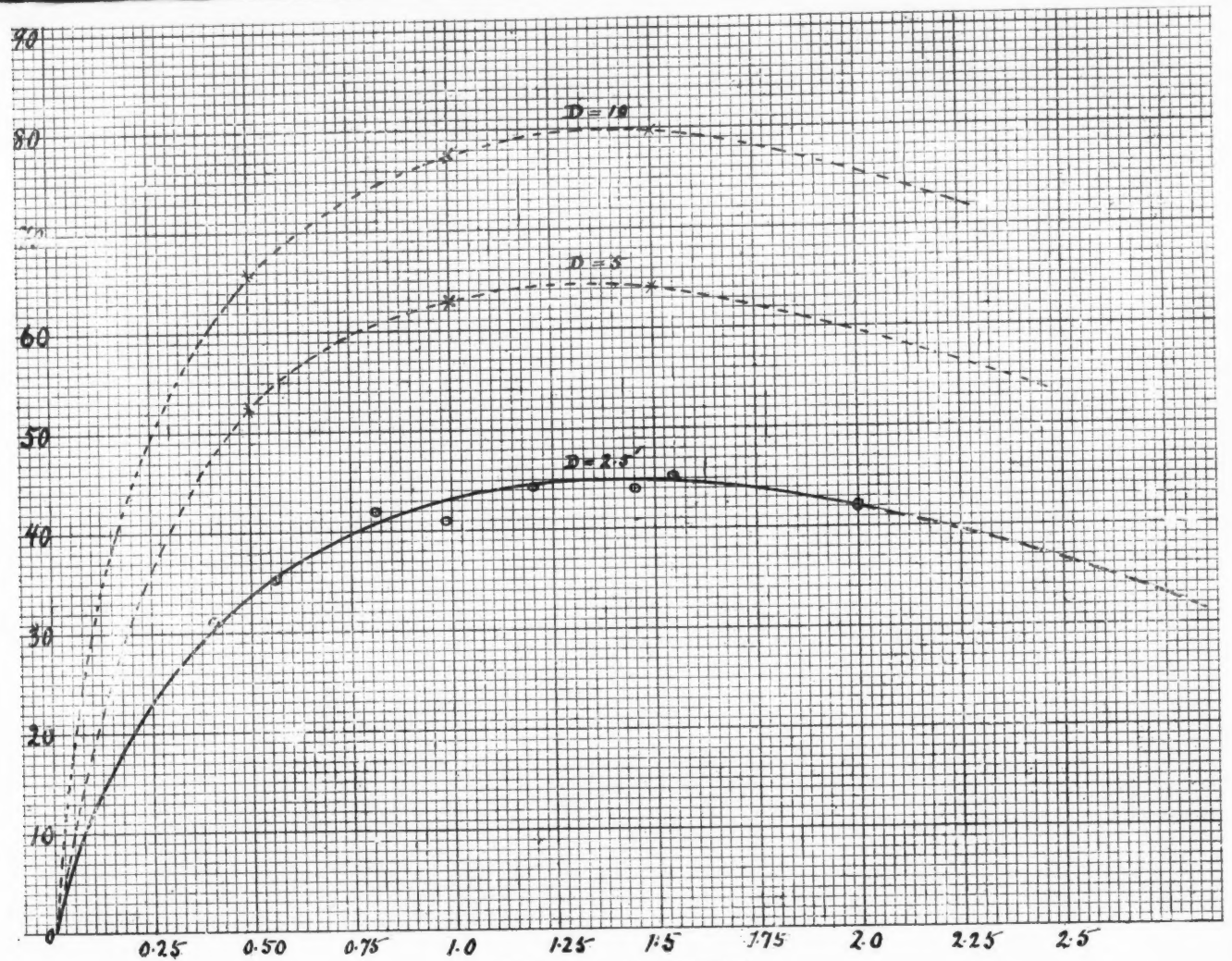

Maximum Efficiency
70
80
60
50
40
30
20
10
0
D = 10
D = 5
D = 2.5
0·25
0·50
0·75
1·0
1·25
1·5
1·75
2·0
2·25
2·5
P ÷ D = Pitch-Coefficient.

PLATE III

Efficiencies of Screws of Pitch-Coefficient = 1·0 and various diameters

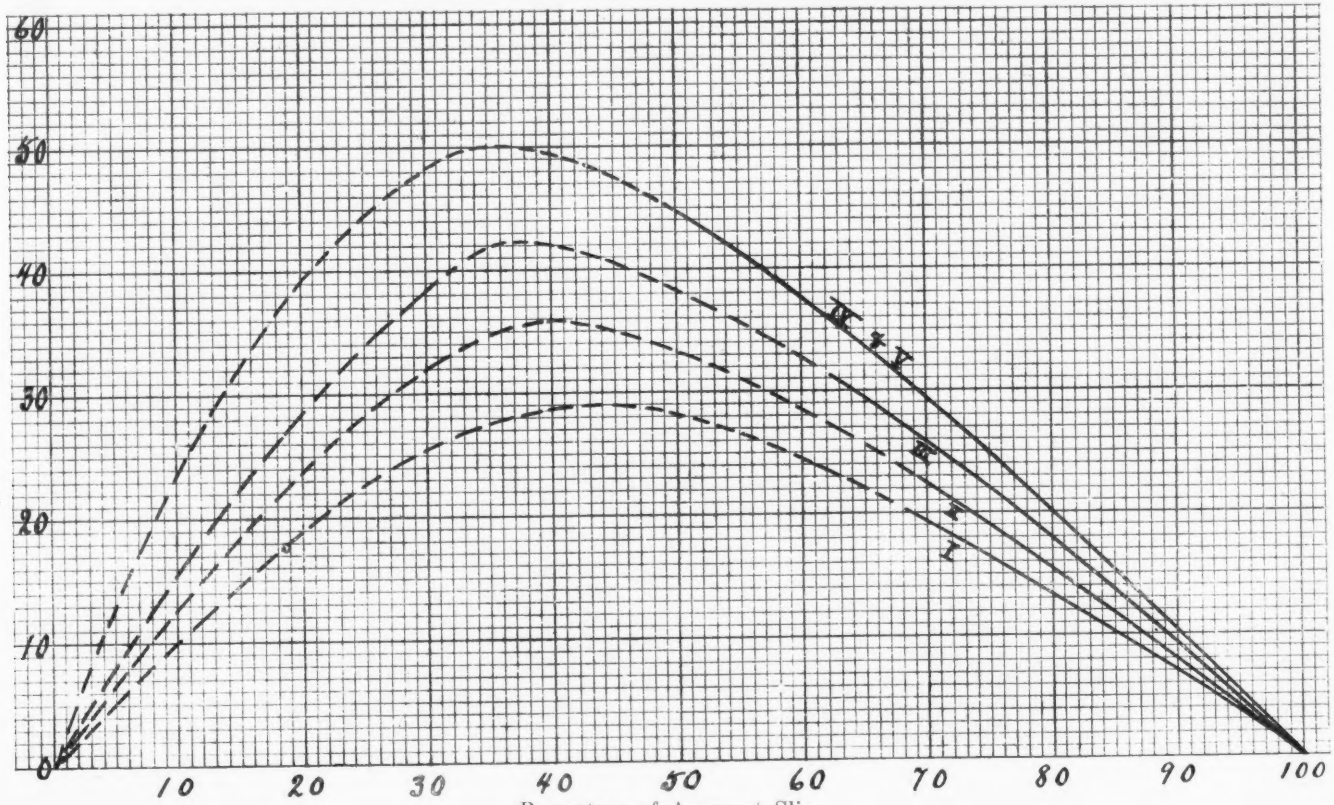


PLATE V

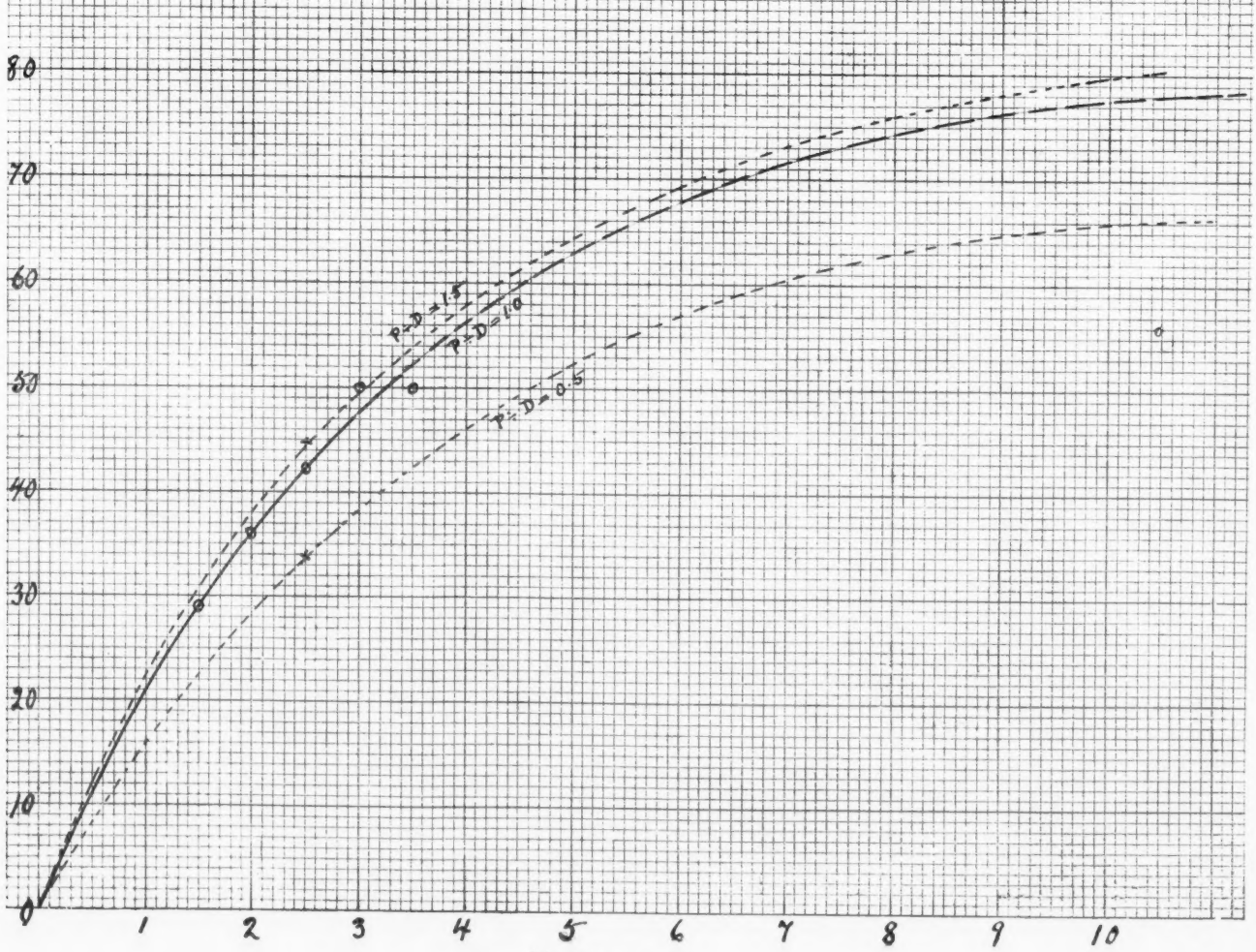
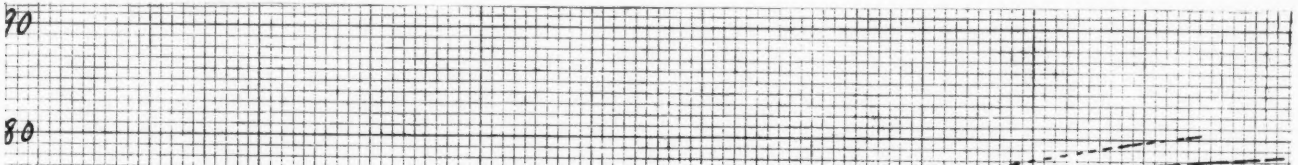
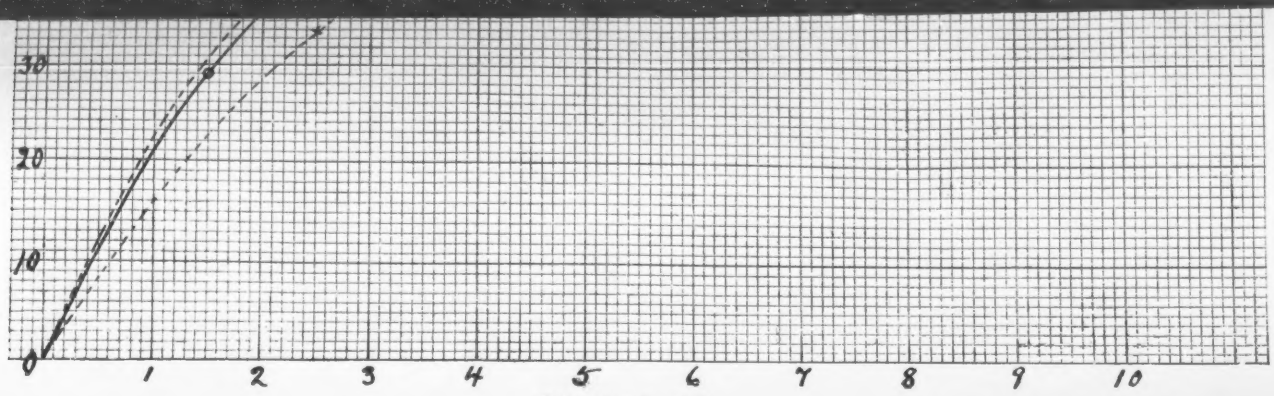


PLATE VI

Percentage of Apparent Slip for Maximum Efficiency

Relation of Maximum Efficiency and Diameter

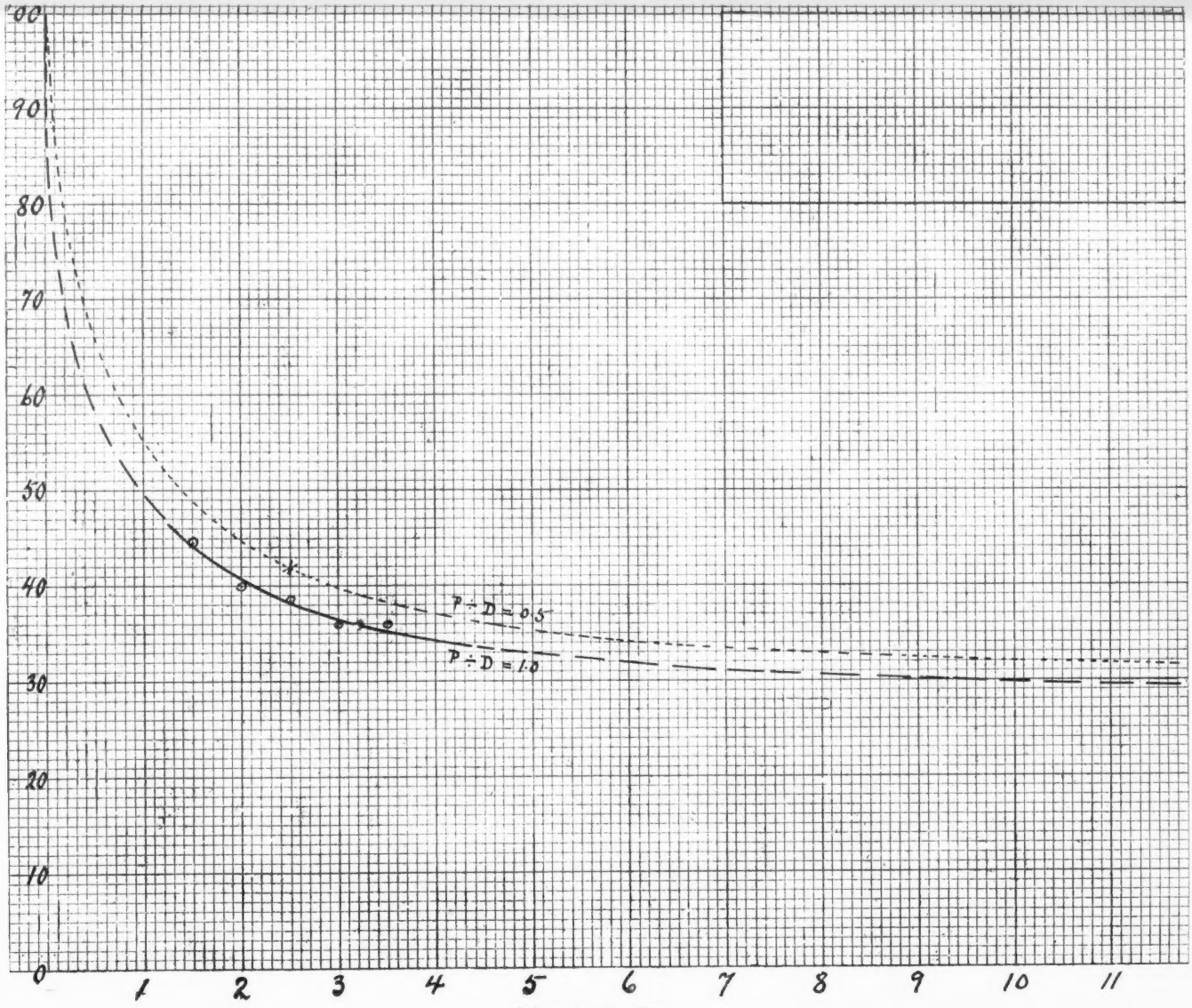




Diameter in Feet

PLATE VI

Percentage of Apparent Slip for Maximum Efficiency



Percentage of Apparent Slip at Maximum Efficiency

Diameter in Feet

PLATE VII

from the full line of Plate III. by drawing similar curves through the points marked × derived from Plate III. The dotted line for P ÷ D = 1·5 would indicate a possible attainable efficiency of about 80 per cent. at 10 feet diameter. Most modern propellers do not nearly attain this efficiency, but then most of them have finer pitch coefficients and are of smaller diameter.

Plate VII. gives the percentage of apparent slip at the point of maximum efficiency, abscissae being diameters; the full line is derived from the results given in Plate V. and the dotted line from the full line curve of Plate IV., as previously explained.

Although all of these results should be extended by the use of propellers of greater size and moving at greater axial speeds, they nevertheless indicate very clearly some of the grave mistakes made in many modern designs.

They show that the efficiency increases with increase in pitch-coefficient, up to a maximum value at about P ÷ D = 1·35; and they show that the efficiency increases as the diameter increases, at first, however, rapidly and afterwards much more slowly. They clearly indicate the fallacy of coupling direct a fine-pitch propeller to a high-speed motor and expecting efficient results.

The proper method would be to select a maximum diameter that can easily be accommodated to the design of the whole machine (with perhaps 8 to 10 feet as a practical present limit), and with a pitch-coefficient of about 1·35. Then figure out the speed of the propeller from the designed working speed of the aeroplane or dirigible (allowing the proper percentage of slip as given in Plates IV. and VII.) and then gear down the speed of the motor to the proper speed of the air-screw. This should give the maximum efficiency for the given combination of elements. Of course there is a certain loss in this geared-down transmission, but it would be much more than offset by the gain in propeller efficiency.

By actually weighing my propellers, Nos. I. to V., I have found that, for similar type, material, etc., the weight of a true screw increases as the cube of the diameter. Considering this fact and also the shape of curve, Plate VI., it would hardly seem admissible to use a propeller much greater than 9 feet in diameter for an aeroplane. For such a propeller, with a pitch-coefficient of 1·4, I have worked out the following table, allowing 28·6 per cent. slip with an indicated efficiency of about 78 per cent.

R.p.m.	Miles per hour	B.HP.	Thrust lbs.	Lbs. thrust per B.HP.
200	20·5	2·93	41·8	14·26
400	41·0	23·4	167·0	7·14
600	61·3	79·0	376·0	4·77
800	82·0	187·5	670·0	3·57

A study of the above table throws some light on the difficulties that beset the aeroplane designer at the present time.

There has been much easy-going talk about aeroplanes travelling 100, 150, and even 200 miles an hour, and inherent stability lies in the direction of these high speeds that are relatively great in comparison to the usual air-currents; but when we consider the rapid decrease in the *possible* thrust per HP. (even with a propeller of very high efficiency) it gives us pause for thought. A refinement of the whole design of modern aeroplanes would doubtless go far towards increasing the present speeds, and it would probably be necessary to use a smaller propeller than the 9-ft. one cited above; but if we do, we must lose in efficiency, and, of all mechanical appliances, the aeroplane calls for the highest possible efficiency at every point. On the efficiency of every part the efficiency of every other part to a certain extent depends; and the efficiency of the whole depends, in compound ratio, on the efficiency of the component parts.

The air-screw, per se, is not necessarily an efficient instrument for the economical conversion of power, but in the past far too little attention been given to the subject of proper diameter and proper pitch-coefficient, both of which are of far greater importance than the curvature of the blades or the special shape of the propeller.

The Wright Brothers deserve great credit for adopting propellers of the proper diameter and pitch-ratio, gearing down the speed of the motor to the proper speed for the

propeller, and the comparatively low horse-power of their motor and high efficiency of their machine, as a whole, give ample testimony of the superior efficiency of their propellers.

While the efficiency of most aeroplane propellers is supposed to be in the neighbourhood of 50 per cent., the Wright screws have an efficiency of about 65 to 70 per cent., and a well-known authority has found, by theory, that an air-screw should attain an efficiency of about 80 per cent., which is about the limit indicated by the writer's measurements.

It is quite possible that, in the extension of the curves, I have fallen into error at the maxima points, and that a practical maximum efficiency lies nearer 70 per cent. than 80 per cent. for propellers of 10-feet diameter and 1·4 pitch-ratio. Of course this matter can only be satisfactorily settled by greatly extending the experiments described in this paper; propellers of larger diameters should be tested, and, above all, propellers travelling at a much higher rate of speed, so that the maximum point of each curve can be definitely determined by actual experiment.

I greatly regret that my own experiments have been so limited, but heretofore we have had no tests of propellers having axial motion, and the results given in this paper, while perhaps only tentative, nevertheless give a good indication of what may be obtained.

At the present time, no question is of greater importance to the scientific and engineering phases of aerial navigation than this question of propeller efficiency, and it is to be hoped that some person or body, having greater resources, will extend the results presented in this paper.

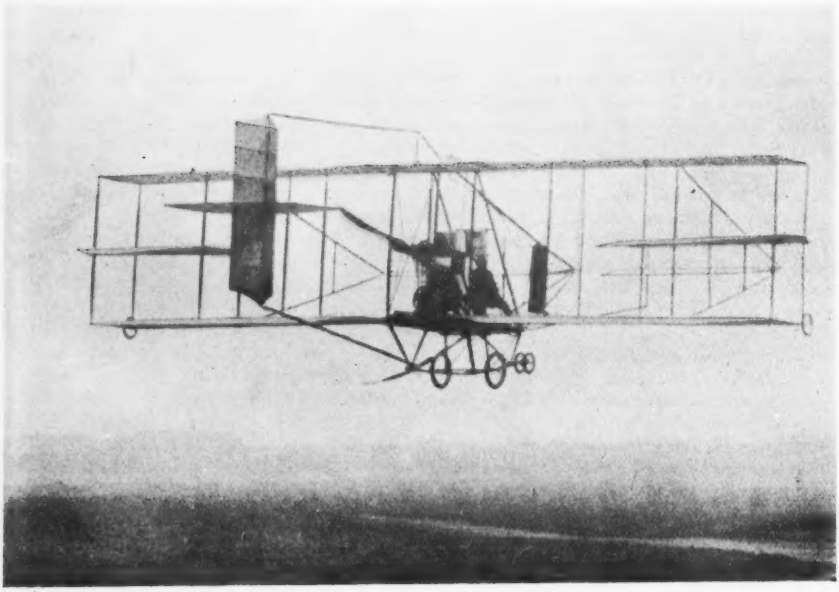
MEMBERS' MACHINES: No. IV

THE CODY BIPLANE

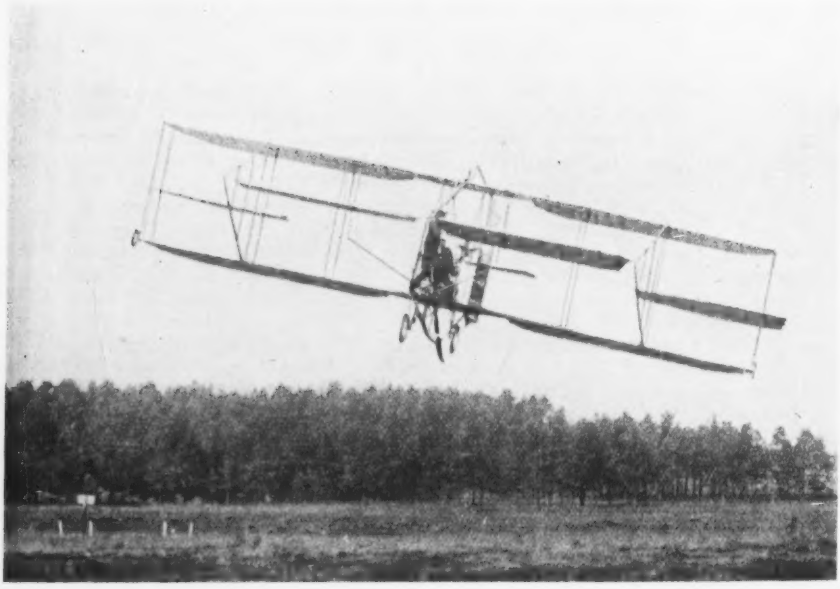
On Saturday, December 31, 1910, Mr. S. F. Cody won the "British Empire Michelin" Cup for the past year with a magnificent flight in circuit of 185·46 miles, in 4 h. 47 min. The machine with which this great success was scored is a biplane with two independently mounted elevators in front and two balancers situated between the main planes.

The following are the chief dimensions:—Main planes: span, 46 ft.; chord, 6 ft. 6 in.; vertical distance between planes, 8 ft. 6 in. Area: 690 sq. ft. Gross weight (in flying order): 1,400 lb., giving a loading of 2 lb. per sq. ft. of area. Total load which can be carried is about 6 cwt. Length o. a.: 38 ft. 6 in. Span o. a.: 49 ft. 6 in. Height: 13 ft. Elevators (each): span, 13 ft.; chord, 4 ft. 6 in.; mounted 12 ft. in front of the main planes. A cruciform tail is mounted 14 ft. behind the main planes; its horizontal plane having 8 ft. span by 4 ft. length; its vertical plane having 8 ft. 9 in. height by 4 ft. length. This tail is provided for the purpose of partially correcting the torque of the propeller. The gliding angle is 1 in 7. The main planes are set at an inverted dihedral angle with the centre raised 6 in. above the outer extremities. The centre of gravity of the aeroplane lies 6 inches in front of the main planes, and the centre of resistance 2 or 3 inches below the propeller axis. Most of the weight is massed in a space 6 ft. square, situated 2 ft. 6 in. from the rear edge of the main planes and 2 ft. from the forward edge. The moment of inertia about the lateral axis has, therefore, been kept low; it appears to be in the neighbourhood of 2,500 ft.-lb.

Many ingenious novel features are embodied in the machine: notably, the method of control, the section of the planes, the chassis, and the method of mounting the propeller. In the Cody control the steering-wheel is capable of three motions: (1) rotation, (2) backward and forward motion, and (3) lateral motion. Of these, the first, rotation, operates the rudder in the ordinary way; the second motion actuates both

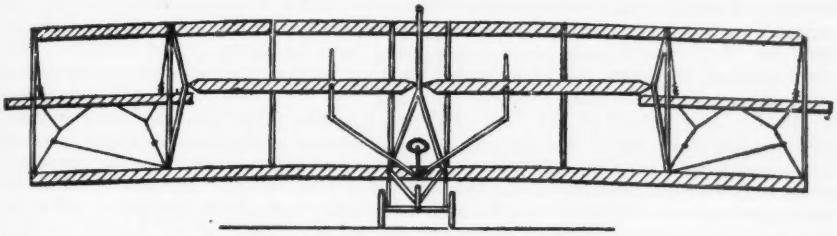


Rear View of Cody Biplane during its record flight

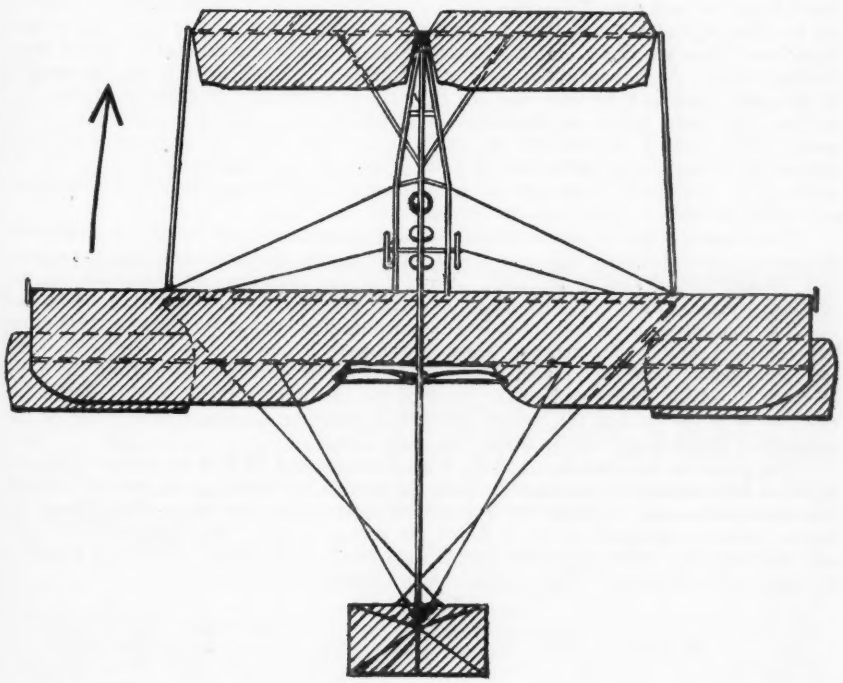


The Cody Biplane taking a sharp turn (the lower elevator and balancer are both depressed)

THE CODY BIPLANE



ELEVATION



PLAN

elevators together, and the third motion operates the balancers, elevators and rudder in conjunction. The steering-column is pivoted, at about one-third of its length from the lower end, by horizontal trunnions to a horizontal shaft. These trunnions are formed on a ring mounted between two small pulleys fixed to the steering-column. The lower end of the column is pivoted to the outwardly expanding elevator-rods, which are pivoted at the outer end to depending levers on the elevator. Bowden wires are wound around each pulley, and are connected to the rudder; these wires pass over small pulleys carried by a small vertical lever on the horizontal shaft, and by other small pulleys at the front of the lower main plane before being cross-connected to the rudder. The steering-wheel, therefore, operates the rudder when rotated, and also when it is given side-motion. From the end of the same vertical lever wires also pass to the balancers, or ailerons, over pulleys at the front of the main planes; the balancers are normally held in position by elastic springs. Thus, a side-motion of the steering-wheel operates the balancers and automatically actuates the vertical rudder in the opposite direction, so as to correct the side drag of the balancer which is depressed. The lower end of the steering-column is pivoted to two bamboo rods, which spread outwards and are connected to the separately-pivoted elevators. A side movement of the steering-column will, therefore, depress one elevator and raise the other in sympathy with the balancers, and give a very strong lateral control to the machine.

In section the main planes are of a peculiar character. The front edge is blunt and is formed by the front spar. The rear spar is situated at about one-third of the chord from the back edge. The ribs are bent over the spars in the ordinary way, tapering to a fine edge at the rear, but the camber of the lower rib is greater than that of the upper one; thus the ribs are brought into contact at about one-third of the chord from the front edge. At this point the camber is about 4 in. At this point, too, the section of the main plane is very thin, and the equivalent is obtained of a double stream-line surface. The main planes are distanced by struts of oval section, $4\frac{3}{4}$ in. by $1\frac{1}{8}$ in. at the centre, and tapering off towards the extremities. The ends are provided with steel sockets which engage the ball-heads of bolts which are connected by steel straps to the main spars. A cross bolt through the socket and bolt-head connects the two together, and allows a limited "universal movement."

The chassis, which is of exceedingly strong construction for running over broken ground, is built wholly of hickory. It consists of a long skid provided with toe wheels and a kangaroo-tail skid at the rear. Above the long skid are two horizontal bearers to which the main plane is rigidly connected. The passenger's and pilot's seats are carried by a bar connected at the rear by a strut to the long skid, and at the front to a cross-bar between the bearers. The running wheels are pivoted by steel tubes to the front of the horizontal bearers and are pressed downwards by helical springs. Wires from the axles of these wheels are connected to the front of the lower main plane so that, when the machine is in the air and the weight is removed from the running wheels, some of the pressure of the springs is taken up by the main planes.

The propeller is of wood—of 11 ft. 4 in. diameter and 13 ft. 6 in. pitch—and runs at about 600 revolutions per minute. It is mounted in ball bearings supported between the main planes and is driven by a 2 to 1 reduction chain and chain-wheels from the engine, which is mounted on the front of the bottom plane. The comparatively large size and low speed of the propeller enable it to engage a large area of air and to attain a considerable efficiency. This is shown in the following table:—

Machine	Air engaged by propellers sq. ft. per HP.
Farman	0·77
Maxim (1893)	1·7
Cody (1910)	2·0
Maxim (new machine)	4·4
Wright (ordinary type)	4·5
,, (original type)	8·1

The engine consists of a 50–60 HP, 4-cylinder, vertical Green engine, running at about 1,200 revolutions per minute. A circular-hole Zimmerman radiator, 4 ft. high, 1 ft. wide, and 2½ in. thick, is mounted at a distance of between 5 and 6 ft. in front of the aviator, in such a position that the air which strikes the aviator passes through the radiator. Much beneficial warmth is thus obtained, while the position is such that the view is not obstructed.

A. P. THURSTON

NOTES

Fatalities of 1910 To the list published in our last issue we have the sad task of adding the names appearing below. It is our duty to record the names of those dead in the cause of aviation both that they may be held for ever in the honour that they deserve, and that, by seeing the heavy price paid, the value of the new science may be estimated at its true worth. There is always an outburst, whenever an accident occurs, from mean-spirited hen-hearted creatures who demand that because flying has its perils, like all other means of locomotion, it should be abandoned. Fortunately for humanity such people are in an exceedingly small minority. It is inevitable that we must pay for progress, and that fatalities will happen as regularly in aeroplanes as they do on the railway in conformation with the law of averages. Our chief concern is to bring the average to its lowest possible dimension, and this result will be most speedily brought about by eliminating unnecessarily dangerous features in competitions, by offering prizes for improved construction and constructional devices, and by paying as much attention to the science as hitherto has been bestowed upon the sport.

Date	Name	Nationality	Machine	Place
Nov. 17	R. Johnstone	American	Wright	Denver
Dec. 3	H. Cammarota H. Castellani	Italian	Farman	Centocelle
Dec. 22	C. Grace	Irish	Short	Lost at sea
Dec. 26	G. Picollo	Italian	Blériot	Sao Paulo (Brazil)
Dec. 28	A. Laffont M. Pola	French Spanish	Antoinette	Issy-les-Moulineaux
Dec. 30	Lieut. de Caumont	French	Nieuport	St. Cyr
Dec. 31	J. B. Moisant	American	Blériot	New Orleans
Dec. 31	A. Hoxsey	American	Wright	Los Angeles

Aeronautics in 1910 In a year of such restless activity and solid achievement as marked the past twelve months it is difficult to single out main features of progress and point to clear lines of development. On consideration, it will probably be agreed that first place should be given to the emancipation of the aeroplane from the confines of carefully selected and prepared flying grounds: the era of long cross-country flights has begun. London to Manchester, a distance of 188 miles, was flown in April, in two stages, by Paulhan on a Farman biplane; in May, Curtiss covered the 160 miles between Albany and New York; later in the year Leblanc won the "circuit de l'Est"—a circuitous course, covering some 500 miles, in six stages—on a Blériot monoplane. The English Channel was crossed no less than six times: by De Lesseps, Rolls (twice in a single flight), J. Moisant (with a passenger), T. Sopwith, and C. Grace; the Irish channel was flown by R. Loraine on September 11, and Lake Erie crossed on September 13 by Curtiss. But even more triumphant than these achievements was the conquest of the Alps by Chavez, who crossed the main chain from Brigue to Domodossola on September 23, only to meet his death on reaching his goal.

So we may chronicle the passing of the aviation meeting, as it has been known during the past two years; for there is hardly room for doubt but that, having once entered into its stride, the aeroplane will never return to the dull monotony of the aerodrome, save for the strictly utilitarian purposes of practice and test. Even so, these meetings—founded one and all on the memorable Rheims week of 1909—have served their purpose, having proved an incentive to rapid evolution of machine and pilot, and a stimulus to popular interest. Records of every description have, in accordance with expectation, gone by the board, the following being the best performances on record established during the year:—

Distance.—362·2 miles (584·2 km.) in 7 h. 48 m. 31 s., by Tabuteau, in France.
Duration.—8 h. 12 m. 54 s. by Farman, in France.
Altitude.—11,474 ft. (3,497 metres), by Hoxsey, in U.S.A.
Speed—5 km. in 2 m. 45 3-5 s. = 108·7 km. p. h. (67·5 m. p. h.).
Passenger flight.—144 miles in 4 h. 2 m. 30 s. by Lt. Camerman in France.

The British distance and duration records are both held by S. F. Cody, who, on December 31, flew 185·46 miles in 4 h. 47 m. at Farnborough. Apart from the increased skill of the pilot and the greater reliability of the motor evidenced by these performances, it is impossible to chronicle any radical improvement in the art and science of aviation. One would wish to see, during the coming year, prizes offered with a truer regard for scientific development; such prizes, in fact, as were instituted during the past year by Mr. Gould in America and by Mr. P. Y. Alexander in England.

A chronicle, however brief, of the events of this stirring year would be incomplete without a mention of the cross-channel voyages accomplished by the "Clément-Bayard" and "Morning Post" dirigibles, both these vessels being acquired by the British War Office, the former by purchase and the latter by presentation, on their arrival in England during October.

THE NEW WRIGHT CONTROL

THROUGH the courtesy of a valued American correspondent, we are able to furnish members with drawings and detailed account of the new control which is fitted to the new pattern Wright biplane.

The new Wright biplane is similar to the original type, but the front elevator is discarded and a tail or horizontal plane placed in rear of the twin rudders. The skids are fitted with two wheels to each skid. On the axle of each pair of wheels there slides a sleeve with two plates furnished with six small bolts. Straps with another set of bolts go under the skid, six small rubber bands join the two sets of bolts. The main planes are 39 ft. 6 in. span, as against 41 ft. span in the original type and 36 ft. span in the U.S. Government machine. The engine-power is also considerably increased, the bore being $4\frac{3}{8}$ in. by 4 in. stroke. The total weight, exclusive of the pilot, is about 800 lbs.

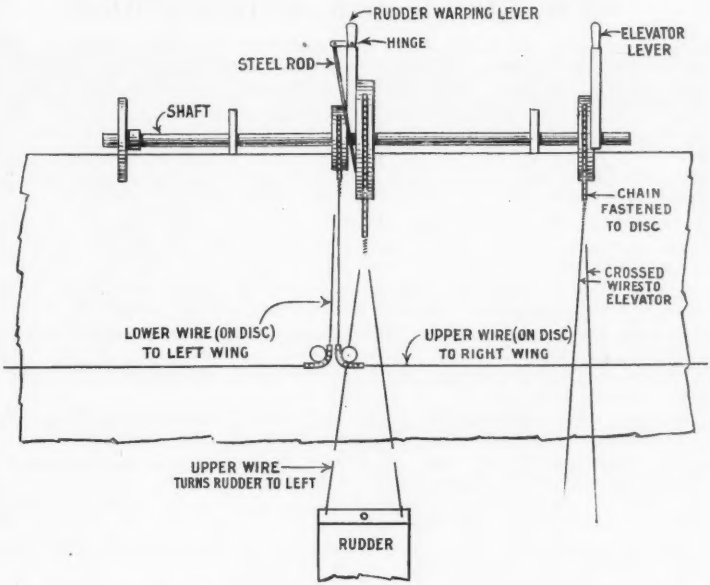
The tail, which is used as an elevator, is a single horizontal surface rigidly attached by its leading edge and by two fixed guys (see diag.) to the rear outriggers. Two-thirds of its rear surface are flexible and are warped up and down for steering by wires that run over pulleys and lead to a vertical disc, encircled with a flat steel friction band, operated by a lever at the pilot's right hand. Over this disc runs a chain, to which the wire ends are attached. The disc is arranged to remain in any position in which it may be placed, so that the pilot may take his hand off to attend to the motor. As the wires cross before reaching the chain, pushing the lever forward warps the elevator down, and *vice versa*.

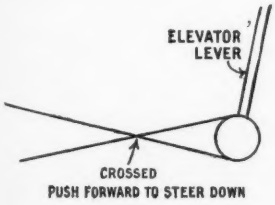
The movements of the left-hand lever are particularly interesting. It operates the vertical rudders with or without warping the wings at will. Moving the lever as a whole forward turns the rudders to the left and warps the right wing down, and *vice versa*. The upper end or handle of this lever is hinged and has a steel rod attached to it which connects with a vertical disc mounted freely on the cross-shaft to which the other levers and discs are attached. "Breaking" this handle to the left, rotates the disc forward and pulls the rudders to the left without warping the planes, and *vice versa*. This operation is made clear by the diagram. The warping and rudder discs (or rather sectors) are held together by a spring friction which can be adjusted to the requisite amount. This holds the rudder at any required angle.

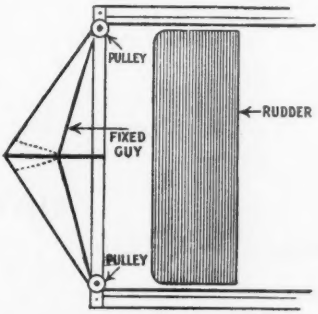
It will be noticed that the machine can be handled from either of the two seats as the warping and rudder control-lever is in the centre with an elevator control-lever on either side. The position of the pupil or passenger on the machine depends on whether the pilot is a right or left-handed driver.

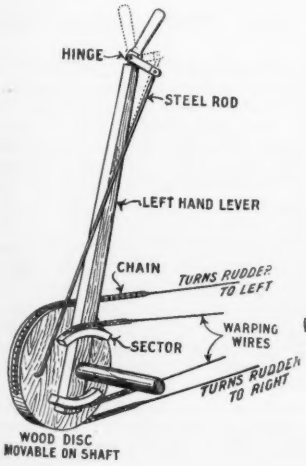
The effect of discarding the front for the rear elevator has been naturally to increase the longitudinal stability and practically to eliminate undulations in the flight path, but the machine is not so quick in responding as it was with the original front elevator.

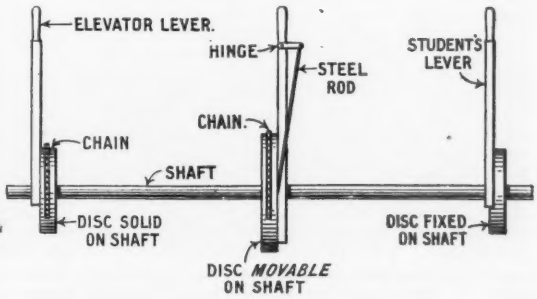
The small Wright machine known as the "Baby" is of a similar type to the above with the same arrangement of controls. There is, however, only one seat and one elevator lever as the machine is too small to carry a passenger. The span of the main planes is 26 feet with a 3 ft. 6 in. gap. The total supporting area is 173 square feet. The tail plane has a 7 ft. span and a depth of 18 inches. The anti-skidding "blinkers" placed in front of the machine are nearly as large as those used on the large machine, but of a somewhat different shape.


RUDDER WARPING LEVER
HINGE
STEEL ROD
ELEVATOR LEVER
SHAFT
CHAIN FASTENED TO DISC
CROSSED WIRES TO ELEVATOR
LOWER WIRE (ON DISC) TO LEFT WING
UPPER WIRE (ON DISC) TO RIGHT WING
UPPER WIRE TURNS RUDDER TO LEFT
RUDDER


ELEVATOR LEVER
CROSSED
PUSH FORWARD TO STEER DOWN


PULLEY
RUDDER
FIXED GUY
PULLEY


HINGE
STEEL ROD
LEFT HAND LEVER
CHAIN
TURNS RUDDER TO LEFT
WARPING WIRES
SECTOR
TURNS RUDDER TO RIGHT
WOOD DISC MOVABLE ON SHAFT


ELEVATOR LEVER.
HINGE
STEEL ROD
STUDENT'S LEVER
CHAIN
CHAIN
SHAFT
DISC SOLID ON SHAFT
DISC FIXED ON SHAFT
DISC MOVABLE ON SHAFT

NEW BOOKS AND PUBLICATIONS

*Aeronautical Classics: No. 5.—Gliding. Percy S. Pilcher: To which is added the Aeronautical work of John Stringfellow. London: Aëronautical Society of Great Britain, 1910. 1s. n.

*The Boy's Book of Airships. Harry Delacombe. London: Grant Richards, [1910.] pp 284. 4s. 6d.

*Peut-on Voler sans Ailes? Paul Colliard. Paris: Librairie Aéronautique. 1911. pp. 109. 3 francs.

*Deinhardt-Schlomann Series of Technical Dictionaries in Six Languages. Vol. X. Motor Vehicles. Rudolph Urtel. London: Constable. 1910. pp. 996. 12s. n.

*Aeroplane Patents. Robert M. Neilson. London: Constable. 1910. pp 91. 4s. 6d. n.

Les Oiseaux de Gloire. P. N. Chilot. Paris: Wellhoff and Roche. [1910.] pp. 12. [Contains two poems entitled "Circuit de l'Est" and "Héros et Martyrs."]

*Réglementation de la Navigation Aérienne: suivis des Projets de l'Aéro-club de France. Guillaume Desouches. Paris: Librairie Aéronautique. [1910.] pp. 53. 2 francs.

*Jahrbuch über die Fortschritte auf allen gebieten der Luftschiffahrt, 1911. Ansbert Vorreiter. München: Lehmanns. [1910.] pp. 507. 10 marks.

*Air Sovereignty. Dr. J. F. Lycklama à Nijeholt. The Hague: Martinus Nijhoff (London: Luzac). 1910. pp. 86. 2s. 6d. n.

*Flying Machines: Construction and operation. W. J. Jackman and T. H. Russell, with introduction by O. Chanute. New York: C. C. Thompson. 1910. pp. 250. $1.00 n.

*Engineering Abstracts. Vol. 1. Jan.—Dec., 1910. London: International Institute of Technical Bibliography (57, Chancery Lane). 1910. Sub. £4 p. a. post free.

*All the World's Airships (Aeroplanes and Dirigibles) Flying Annual. Fred. T. Jane. London: Sampson Low. 1911. pp. 464. 21s. n.

Etudes sur les Flexions et Courbures des Ailes et les Hélices Aériennes. Docteur Paul Amans. Paris: F. L. Vivien. 1910. pp. 89. 3 francs.

*Interim Report of the Advisory Committee for Aeronautics on the work for the year 1910-11. London: H. M. Stationery Office. 1910. pp. 30. 1s. 2d. n.

* Notice of this book will be found in the present issue.

REVIEWS

Air Sovereignty. By Dr. J. F. Lycklama à Nijeholt. (The Hague: Nijhoff; London: Luzac, 1910. pp. 86. 2s. 6d. net.)

The learned author of this work rightly considers the present moment opportune for a thorough discussion of the general principles upon which an international agreement to regulate air traffic in peace and war should be based: he contends that those who have taken this question up prior to the present date have been premature, and that the regulations which they have drawn up will have to be put aside, in face of situations wholly different from those which the authors of such regulations contemplated. But now "recent years have proved such a splendid success for aeronautics that really it seems justifiable for law to begin to take its share in the aerial labour." . . . Besides, an international agreement concerning the principles has the great advantage of cutting off the possibility of conflict. In former times, every state would have decided for itself which line it was to take; for instance, the one would proclaim absolute freedom of flight; another would demand formalities, the honouring of its flag; another again would close the air space to every foreigner; conflicts would arise, wars would probably not fail to follow, and only a long time afterwards would one search for the custom and come to an agreement as to which principle seemed to be most equal to all interests. The practice of recent times has brought to the fore the great advantage of international regulation where international interests are concerned. To guarantee this advantage to air traffic, an international interest *par excellence*, it will be wise to settle which are to be the leading principles for the new sphere of law. On those principles the new rules will be safely built, the states all working together or each state for itself, according to the character of the cases. There are two schools: one claims absolute freedom of the air for aeronauts, the other claims sovereignty over the air space above

WALTER BROOKINS *(Wright biplane)* TURNING IN $6\frac{2}{5}$ SECONDS

it for the ground state: the former admits that certain concessions must be made to the ground state, and the latter expects the sovereign state to allow reasonable freedom without enforcing harrassing restrictions. The author, who belongs to the latter school, argues the case for both sides with absolute impartiality, but, as might be expected, comes to the conclusion that the sovereignty of the ground state should be paramount. The question of the ground landlord's vested interests in the air-space had first to be legislated for in connection with running telegraph wires over the land, and it is noteworthy that in the case of Holland, France, Germany, and Belgium, the state appeared to consider that the stretching of wires over another man's property was not lawful unless legally admitted, and proceeded to legislate for the stretching of the wires on this assumption. By this action, the state in the first instance recognised the rights of private ownership over the air-space, and in the second instance took the state's sovereignty over the air-space as granted. In England, on the other hand, the State has to obtain the permission of the private owner, and cannot compel him to allow wires to be stretched over his land. This instance of the telegraph wires shows how pressing is the case for international agreement on the question of principle, before any real progress can be made in drawing up a code of regulations which shall be binding, not only in peace, but also in war.

The theory extending the authority of the sovereign state over the air-space, involves as a first consequence that, where the surface of the globe is without a sovereign, the air-space overhead has no sovereign either: thus, above the open sea and above unoccupied land, the air-space is free. There are many points which will have to be legislated for, some of extreme complexity. The author treats of "States partly dependent on other States," states forming a "Real Union and Federal State," "Maritime Belt," "International Rivers and Canals," "Extension of Sovereignty outside the State Domain," "Military Aircraft," "Merchant Aircraft," &c.; and then proceeds to discuss the consequences of air sovereignty as to the Laws of War. The consideration of the Theatre of War and the air domain of neutral states involves no great difficulties; but when we come to the "Right of Passage," we are faced with the fact that neutral states intervening between two belligerent states, can, by virtue of their air sovereignty, prohibit the passage of either state's air vessels over their territory, and thus render abortive any attempt of the hostile air fleets to take part in the operations under arms. But after all, as the author points out, the same conditions have always held in respect to the land territory of neutral states; why, therefore, should it be considered unreasonable to apply the same principles to the air domain. It is pointed that the practical difficulties in respect to "Right of Asylum" will be greater than in the case of maritime ports; but that they can be overcome, there is no cause to doubt; the regulations must observe the general principle that the neutral state may on no account assist the belligerents. On the land frontier the neutral state must be severe, for there the air forces of the belligerents do not come from regions where landing was impossible, but simply not desirable; and landing in neutral territory will mean evasion from the enemy, either out of the enemy's air domain, or out of one's own air domain, pursued or menaced by the enemy.

In conclusion, we think that the author wisely pleads for an international agreement on the principles which he has so ably discussed, as a necessary preliminary to the framing and codification of regulations intended to govern international aerial relations.

F. G. S.

Réglementation de la Navigation Aérienne: suivi des Projets de l'Aéro-Club de France. By Guillaume Desouches. (Paris: Librairie Aéronautique, 1910. 53 pp. Price, 2 francs.)

Under the title "Réglementation de la Navigation Aérienne," M. Guillaume Desouches has given to the world in a convenient little volume of 53 pages, a concise dissertation on the subjects which can usefully be included in a code of regulations, followed by a "Reglement" of 42 articles for internal use, and a "Code International" of 62 articles for international use. M. Desouches is a practising attorney of the Civil Tribunal of the Seine, and Vice-President of the judicial committee of the French Aero Club: he writes, therefore, as an expert, and with the authority of the Aero Club behind him.

The preliminary dissertation is divided into six sections, which treat respectively of (1) The Ocean of Air; (2) Aerial Vessels; (3) Aerial Routes; (4) Harbours; (5) Registration and Nationality; (6) Customs. The discussion in each case is concise and lucid, bringing out clearly the points on which legislation is possible and desirable, and putting on one side those which are in practice better left to individual discretion. The "Reglement" is the result of M. Desouche's original work, modified and added to by the Committee of the Aero Club de France, after discussion at six meetings, and is in its present form submitted for the approval of the Minister of Public Works by the Managing Committee of the Club. It consists of 42 articles under the following headings:—Preliminary; Circulation in the Air; Landing places and shelters (ports d'accès); Stations for registration (ports d'attache); Octroi, penalties, &c. The "International Code," prepared under the same auspices as the "Reglement," is an amplification of

the latter to meet international requirements, and is also presented by the Committee to the Minister of Public Works. It consists of 62 articles under the following heads :—Protocol, aerial routes, circulation in the air, landing places and shelters, limitations, landing places and formalities, customs, penalties, permits, nationality. Space will not permit us to discuss the above articles in any detail, but it will interest our readers to learn that the following points are provided for :—Flight over unenclosed land is free, but over enclosed land it is forbidden to pass within less than 50 metres, or remain at a less altitude than 500 metres. Every obstacle of more than 50 metres in height shall have a white light on it at night. Railway stations shall have their names in large white letters on the roof. Aerial vessels shall not pass closer than within 50 metres of each other. Land in the vicinity of a landing place or regular garage is subject to the descent and landing of aerial vessels, and the owners may not in any way oppose or prevent such descent or landing, but may claim an indemnity both for damage and occupation. The formalities to be observed on landing on foreign territory are based on much the same lines as those for motor cars.

In conclusion, we recommend those who are interested in the subject, to read this admirable little book carefully, believing, as we do, that it can scarcely fail to be the basis of discussion for the formulation of internal regulations for all countries, as well as for an international convention for use in time of peace. The vexed question of the freedom of the air as opposed to the sovereignty of the state underlying it, is treated in a plain commonsense fashion in the following words :—" Henceforth the control of states over air vessels can only be practically exercised, in peace time at the moment of landing, in war time within the range of specially designed quick-firing guns : the result is that the point at which a foreign pilot touches the land, constitutes for him in his relations with the state in which he lands, the true frontier."

The international code does not deal with the difficulties which arise in war time, nor with those other difficulties which arise in peace time in connection with aerial vessels being used over a foreign state for the purpose of obtaining intelligence and information on naval and military matters, under the guise of tourist, sporting, or commercial purposes. It appears, however, that before any international code can be agreed upon, even for use in peace time only, it will be necessary for the countries interested, to discuss and agree upon certain principles upon which rules may subsequently be based ; the questions of principle are indeed somewhat numerous and in some cases sufficiently complex : an international code of regulations applicable to war time involves still greater difficulties in obtaining the necessary preliminary agreement upon questions of principle. A study of Dr. J. F. Lycklama à Nijeholt's work on Air-Sovereignty will make it clear to the reader how necessary is this discussion of principles, before taking the next step and formulating regulations based on principles, upon which international agreement has previously been secured.

F. A. S.

All the World's Airships (Aeroplanes and Dirigibles). Flying Annual. By Fred. T. Jane. (London : Sampson Low, 1911. pp. 464. 21s. net.)

Mr. F. T. Jane's immense and courageous industry has provided the second annual volume of " All the World's Airships " nearly 100 pages larger than the first issue. It contains a Glossary of Technical Terms in English, French, German and Italian, a particularized list of the world's aeroplanes, dirigibles and aerial engines illustrated with photographs and diagrams, a " Who's Who," a directory, and is fully indexed.

The Glossary of about 130 words is decidedly useful and fairly complete. One notices a few proof-reader's errors, such as " helicoptre " for " hélicoptère," " casutcho ic," " soupapa," while " stabilisierungsflächen " appears as the German for " steel." The French too for " body " of an aeroplane is not " chassis," as given, but " fuselage " ; and curiously enough the French equivalents for simple words like " gasbag," " hydrogen " and " non-rigid " are not included.

In the list of aeroplanes and dirigibles the general plan in dealing with each country is as follows :—(1) List of principal societies ; (2) List of journals ; (3) Flying grounds ; (4) Full list of aero clubs, etc. ; (5) Owners of standard-type machines, class A ; (6) Owners of successful types which have not yet attained to standardization, class B ; (7) Owners of miscellaneous machines partly successful and otherwise, class C. Thereafter follow monoplanes and then biplanes in alphabetical order, concluding with dirigibles.

In the development of his scheme, Mr. Jane's arbitrary divisions are no doubt necessary, at any rate they are co rageous. It is to be feared that, in future issues, the scheme will become unworkable. In our review of the first volume we ventured to hint that Mr. Jane was undertaking a task on lines beyond human capabilities, or rather that would require a staff larger than that employed on, say, the *Encyclopædia Britannica*. We hoped that the scheme of the annual work would be entirely altered, that the format, which becomes clumsier as the volume increases in size, would be abandoned ; our prophetic eye saw editor and publishers rushing into confusion and destruction. What formerly was hinted at, we now feel it our duty to declare

unmistakably. The book as it stands has no general value. The "man in the street" will be hopelessly bewildered by it; the expert will progress wearily from A to Z and find that all is vanity and vexation of spirit. The idea of the work is excellent, but the arrangement and the format completely defeat its undoubtedly good intentions.

The list of Aero Engines that forms the first section of Part II. is good, and useful to the superficial reader. The "Who's Who" is worth doing very much better and is remarkable as much for its admissions as its omissions. We cannot help mentioning, in passing, that Henson did not die in 1842, and that if Francisco Lana—who is stated, by the way, to have been a "Jesuit who projected flying machines"—is included, it is rather invidious to omit Da Vinci and Mr. Robert Hooke.

"All the World's Airships" contains an immense amount of information, the type is good, the illustrations are well produced. We recommend it, inasmuch as it is the only work of its kind, and as such is of value as an historical record. We trust, however, that Mr. Jane will seriously re-consider the general arrangement, and in the next edition produce a volume which one can not only keep conveniently at one's elbow for constant reference, but must do of necessity.

—T. O'B. H.

Equilibre, Centrage et Classification des Aeroplanes. By R. Saulnier. (Paris: Librairie Aéronautique, 1910, pp. 58; 3 francs.)

The Saulnier aeroplane has not yet come prominently into the public eye, but its ability to fly is not only testified to by the picture of it in full flight on the cover of this book, but is also assured by the evident grasp of the problem of flight evinced by the author in its pages. The fact that M. Saulnier has designed and flown successfully an aeroplane presumably built in accordance with the theories set forth in his book renders it more than usually interesting. It is with some curiosity therefore that one proceeds to go behind the scenes. Although it cannot be said that the excursion reveals any startling or revolutionary theory, yet the general problems of stability, and so forth, are found to be tackled in so clear and effective a manner that one cannot fail to profit largely by the journey.

The size of the book prevents it being at all exhaustive, and confines it to an exposition of general principles. Their application to the complex problems due to the "internal work of the wind" is not examined. (These problems are, of course, the most important which have to be faced, and unfortunately are difficult of approach by ordinary methods of research. Equations taking them into account are apt to be so full of variables as to be almost useless).

A short résumé "of generalities" is first given, at the end of which M. Saulnier shows diagrammatically the four forces acting in the vertical plane of symmetry of an aeroplane. These are:—(1) The weight P applied to the centre of gravity G; (2) the pull of the screw T along its axis (at right angles to P); (3) the force of sustentation V applied at O (the centre of sustentation) and (4) the head resistance R. When the trajectory is a horizontal right line, V and P are equal and form a couple which M. Saulnier calls the "couple de prépondérance," and T and R form another couple which calls the "couple d'empennage." The above example will serve to show M. Saulnier's methods. The original work must be referred to in order to do justice to his arguments, which do not admit of condensation to any extent. Suffice to say here that his conclusions appear to be sound.

In Chapter I the equilibrium and longitudinal stability of an aeroplane in rectilinear trajectory are examined. A clever use is made of graphic diagrams. For instance, the "couple of longitudinal stability" is the resultant of a composition of the "couple de prépondérance" and the "couple d'empennage," and is clearly exhibited by drawing curves of the two couples one on top of the other. M. Saulnier shows that where machines have considerable automatic stability the curves of the two couples cut each other at about right angles, these angles becoming less as the machines become less stable. The foregoing deals with "indeformable" machines, having no movable stabilisers. A clear exposition of the action of elevators follows.

In Chapter 2 transversal equilibrium is first examined. The action of the wind, turning, the influence of altitude, and landing are next briefly referred to. An excellent diagram is given at the end of the chapter showing graphically the conditions which must be met in order that an aeroplane may leave the earth. It is seen that it is necessary for the curve of head resistance to cut the curve of the propeller-pull at a point in time later than that at which the horizontal line denoting the weight of the machine cuts the curve of sustentation.

The concluding portion of the book is devoted to a study of the classification of aeroplanes. M. Saulnier divides existing types into two classes; those with their centre of gravity at or about their centre of sustentation, and those with the two centres appreciably separated. In the first class he places the Bleriot XI., Curtiss, Nieuport, Esnault-Pelterie, etc., dividing these again into two types according to the disposition of the two heavy masses of the engine and pilot. In the second class appear the Wright, Voisin, Farman, Bleriot XII., Demoiselle, etc. (The radical alterations made so rapidly by the makers, however, are certain to render these classifications liable to modification.) The ordinary classification of aeroplanes as monoplanes, biplanes, etc.,

M. Saulnier shows to be very superficial, and useless as a scientific distinction. An interesting examination of the conditions necessary to enable a machine to glide well follows. The question of landing, M. Saulnier truly remarks, is full of menaces for the future of flying. It is, he says, the chief obstacle to the curtailment of plane area and the attainment of high speeds.

M. Saulnier is not optimistic as to the commercial future of flying-machines, and as he is considering only the present form of "aeroplane," this is not surprising. The future of flying would indeed be dark were it wrapped up solely in the present type of machine.—B. G. C.

Peut-on Voler Sans Ailes? By Paul Colliard. (Paris: Librairie Aéronautique, 1911, pp. 109; 3 francs.)

The position M. Colliard takes up is not quite so revolutionary as would at first sight appear from the rather misleading title of his work. He does not propose to eliminate altogether the ordinary means of obtaining a reaction from the air and fly by merely an effort of will. As summarised by him his position is as follows:—

"The wings (of an aeroplane) are a defective organ and ill-adapted for the effect which they have to produce. Sustentation, which necessitates a certain power, absorbs with wings a very considerable amount of work. There is therefore reason for doing away with the wings of the aeroplane! Sustentation without wings is more economical and surer."

M. Colliard elaborates his thesis through 109 octavo pages (thus showing that, in one sense, there is much to be said for it) but it cannot be said that he arrives at any definite result. His suggested apparatus, which he calls an "aérolet" or "aéromobile," has no wings, but has all the other characteristics of the average monoplane as regards supplementary planes, and also has the screw in front. The axis of this screw is, however, inclined upwards about the same amount as the chord of the aeroplane wing ("6 to 8 degrees for ordinary speeds, up to 20 mètres a second" and "2 or 3 degrees" to "infinitely small" as the speed rises).

M. Colliard argues that the small downward component of the propeller thrust obtained by its slightly tilted axis is sufficient to counteract the downward pull of gravity if sufficient speed can be attained and maintained. In other words, he would act so quickly that he would take gravity by surprise as it were, and not give it time to act. This is perhaps not quite a fair summary of M. Colliard's argument, which is supported by his apparently complete grasp of the mathematics of the ordinary physical laws. Space is, however, lacking in which to set out and examine this argument at full length. M. Colliard summarises the difference between an aeroplane and an "aérolet" as follows:—

"The one is sustained by its wings; the other by its speed."

The difficulty of bringing to earth a high speed machine having no wings is overcome by providing what M. Colliard terms a "plan d'atterrissage." This consists of a number of thin sails which are ordinarily intended to be quite inactive ("de s'effacer complètement dans le lit du vent.") These act as a parachute when coming down. It will not be necessary, however, to go further into this function until M. Colliard has gone very much further towards proving that his proposed machine could ever leave the ground.—B. G. C.

The World's Birds. By F. Finn, B.A., F.R.S. (London: Hutchinson & Co., 1908. 5s. net.)

This is a very handy little volume and will be found most useful to both ornithologists and aeronauts.

Commencing with a brief general description of birds and their ways, a more detailed account follows of each of the different families into which the author divides the Bird world. The peculiarities of each family are noted under such headings as size, form, food, flight, gait, disposition, courtship, economic qualities, etc., while further information regarding the more important species of each class is also given.

The book is a most useful one in every way, and may be safely recommended to everyone interested in the subject. The illustrations are excellent.—J. D. F.

Flying Machines: Construction and Operation. By W. J. Jackman and T. H. Russell with an introductory chapter by Octave Chanute. (Chicago: C. C. Thompson, 1910, pp. 145. 1 $ net.)

This book is avowedly written for the guidance of the novice in aviation, who is seeking practical information on the theory, construction and operation of the modern flying-machine, the wording being intentionally plain and non-technical. Of theory there is strictly none, but much space is devoted to the constitution and operation of different types of machines—most of which, so fast does aviation progress, are already out of date.

An attempt is made to give directions how to construct a glider and a full-sized machine with motor; these, however, would be misleading to non-professional workers. The rest of the book is so loosely and disconnectedly put together that it requires an expert to sift the wheat

from the chaff, and defeats its primary object of being a guide to the tyro. Mr. Chanute is represented by a reprint of his observations on soaring flight and has some graceful allusions to Wenham and other pioneers.

As a popular rechauffé of details culled from various sources, including a defence of the Wright Brothers' patents, and a dissertation on the law of the airship, the book may perhaps appeal to a certain section of the public.—G. P. D. S.

Aeronautical Classics—No. 5. "Gliding." By Percy S. Pilcher. To which is added the Aeronautical work of John Stringfellow. (London: Aëronautical Society of Great Britain, 1911. 1s. net.)

No. 5 of this excellent series gives astonishingly good value for the money. There are thirty-six illustrations, including portraits, photographs and diagrams; and much matter never before published is contained in the text. The basis of the book is Pilcher's lecture before the Military Society in Ireland, reprinted from a pamphlet of which only a very few copies exist. A full memoir gives for the first time the complete history of this great pioneer's work in aeronautical science, and descriptions of all his gliders; while the section devoted to Stringfellow includes, also for the first time, a detailed account of the circumstances which led to the construction of the famous Henson-Stringfellow monoplane, with the text of Henson's letters and of the original agreement and prospectus. The honorary editors are to be congratulated on the successful result of their self-imposed task.—R. C.

Aeroplane Patents. By R. M. Neilson. (London: Constable, 1910. pp. 91. 4s. 6d. net.)

"Aeroplane Patents" is a timely publication, and its opening section of "Advice to Inventors" is quite admirable. The other sections include a review of British patents, British patents and applications for patents from 1860 to 1910, British patentees arranged alphabetically, United States patents from 1896 to 1909 and United States patentees. It must be admitted that most of these sections are of very little value, the scope of the book being too small to embrace all the information necessary for complete elucidation. In the restricted space at his disposal the author has no doubt done his best, but a very much larger work will be necessary to cover adequately this most important side of aeronautics. It is to be hoped that the reception given to the present volume will be sufficiently encouraging to enable Mr. Neilson to deal with the subject in a far more comprehensive way. Such a work is urgently needed.

Deinhardt-Schlomann Series of Technical Dictionaries. Vol. X. Motor Vehicles. (London: Constable, 1910. pp. 996. 12s. net.)

The Deinhardt-Schlomann Series of Technical Dictionaries in six languages are too well-known and universally used to require much explanation. The present volume, edited by Herr Rudolph Urtel, deals with Motor Vehicles and includes a section of some forty pages devoted to airships and flying machines.

The arrangement and indexing could not be bettered, and clever little sketches explain all words the meaning of which may be doubtful. We heartily recommend it to aeronauts and motorists.

The Boy's Book of Airships and other Aerial Craft. By Harry Delacombe. (London: Grant Richards [1910], pp. 288. 4s. 6d. net.)

This is a chattily-written volume of the history and simple principles of balloons, dirigibles and aeroplanes, bringing the reader up to June of last year. The book, which is copiously illustrated with remarkably well-produced photographs and prints, will interest the parents no less—if not more—than the boys themselves. Perhaps rather too much space is devoted to the spherical balloon, but one cannot be captious in the presence of so well-meaning and unassuming a production.

Engineering Abstracts. Journal of the International Institute of Technical Bibliography. (London: Internat. Inst. of Tech. Bibliog., 1910. Subs. [£1 4s. per section p.a.] £4 p.a. post free.)

We have received some of the sections issued by this Institute, whose work is extremely good with the present means at their disposal. "Engineering Abstracts" is published fortnightly in seven sections, viz., Mechanical Engineering, Military Engineering (including Aerial Navigation), Electrical Engineering, Civil Engineering, Mining and Metallurgy, Applied Chemistry and a Supplement, which contains all articles of miscellaneous character which cannot be brought under any of the above headings.

In the subject of Aerial Navigation, which of course interests us most, the great drawback is at present lack of completeness. Most of the articles and books cited seem to be German, and

the editor apparently exercises his discretion as to what articles he shall or shall not include. To be of any great value everything of course must be included, but this would entail tremendous labour as those who have seen Brockett's "Bibliography of Aeronautics" will understand. The Institute are, however, doing very good work and deserve every support and encouragement in their task.

We have also received from Messrs. Spon two pamphlets entitled "Resistance of the Air and the Question of Flying" and "Flight-Velocity," both by Arnold Samuelson, which were published in 1905 and 1906 respectively. They may be obtained for two shillings each and are well worth perusal. Drawings and details of successful flapping-wing models made by the author are included.

CORRESPONDENCE

To the Editors of the AERONAUTICAL JOURNAL

THE LAWS OF AIR-SCREWS

SIRS,—In a letter, published in *Engineering* of Dec. 16th, 1910, Mr. Horatio Phillips has caustically criticised an example which I gave in my article on "The Laws of Air-Screws," appearing in the October number of the Journal. The quotation from my article is this :—"For instance, a sector propeller of 20 ft. diameter, 2 ft. pitch, and 20 per cent. width of blades, would give 570 lbs. per brake horse power, at 10 revolutions per minute" and his comment :—"Now, under the above conditions, about 8·5 lbs. of air would pass through the screw disc per second. The slip-speed = 0·34 ft.-sec. = thrust, say, 0·1 lb."

To say the least, he is not explicit, and perhaps I do not understand the point of cavil, but it is apparently the large value ascribed to *the thrust per brake horse-power*, compared to his figure for the thrust! Mr. Phillips does not give his figure for the thrust per brake horse-power and apparently has simply used the ordinary reaction formula of marine screws (viz. :—$W \times S \div g$) to obtain a value for the thrust. My own figure for the thrust is 0·3 lb., and the HP. to turn the propeller is ·00053 HP., consequently the thrust per HP. is 567 lbs., these figures being the result of experimental data *with air-screws*.

At the present status of our knowledge, I cannot admit a close analogy between marine and air-screws. The two media in which they work are very different; water being almost incompressible, air extremely elastic; one is a liquid, the other a gas. We positively know, by experiment, that when an air-screw rotates at a fixed point the greater bulk of the air that "passes through it" approaches *radially and centripetally*, and it is impossible, even by theory, to assign an exact value to the weight of air "passing through the screw disc." The bulk of the air passes in radially and is thrown out nearly axially, making a very complicated problem.

If this were not so, we might calculate the thrust and the B.HP. from the well-known laws of air-resistance, treating each blade of the screw as an aeroplane having "lift" and "drift." If we do this in the example cited (subdividing each blade into five parts and treating each separately), we obtain a thrust = ·0645 lbs. and HP. = ·0000182; consequently a *thrust per* HP. = 3540 lbs. This would be perhaps approximately true for the first half-revolution, with a 2 blade screw; after that axial and radial motion of the air would at once alter the result.

Again we may calculate the thrust and horse-power, according to the method given in Brewer's "Art of Aviation," pp. 108—109, starting from the fundamental formula for kinetic energy, viz :—$T = \frac{1}{2}MV^2$; in this case, in the example cited, we obtain the thrust = ·0906 lbs. and the HP. = ·0000285 with a resulting *thrust per* HP. of 3180 lbs. Both of these values are much in excess of that given in my paper, but they are both theoretical values, taking no account of radial inflow, eddies, etc., and I prefer to abide by experimental results. It is, of course, apparent that this example, criticised by Mr. Phillips, is an extreme one and is used in my article solely to illustrate the fallacy of considering the lbs. thrust per horse-power, as any proper criterion for judging the merits of an air-screw.

While we are on the subject, it may be as well to mention that *with a perfect propeller of any kind* having 100 per cent. efficiency *and axial motion*, we would have to get 5,500 lbs. per HP. at an axial speed of 0·1 ft. per second, 550 lbs. at 1 ft. per second, 55 lbs. at 10 ft. per second, and so forth. This follows directly and simply from the fact that one HP. = 550 ft.-lbs. per second,

To return to the stato-rotary case "the theoretical thrust per horse-power varies inversely as the velocity of the wake when thrusting against a fixed point." My own experiments, and those of others, show this law to be approximately true and I will take an actual case of a propeller that was not extreme in any way; it was 2·5 ft. diameter with a pitch-ratio of 0·4. The *measured thrust per* B.HP. was 14·04 lbs. at 2,000 r.p.m., and 28·2 lbs. per B.HP. at 1,000 r.p.m.; it would consequently give about 56 lbs. at 500; 112 lbs. at 250; 224 lbs. at 125; 448 at 62·5; and 896 lbs. per B.HP. at 31·25 r.p.m. These thrusts are all *per brake horse-power* and are the natural sequence of *actual measurements on an actual propeller.*

To those who caustically criticise, I would suggest that they present their data in full and be explicit about their own deductions before advising that the work of another be stricken from scientific annals, without reasons assigned.

W. R. TURNBULL

Rothesay, N.B.

PROF. FITZGERALD'S LILIENTHAL GLIDER

SIRS,—A question was addressed to me some weeks ago, regarding a glider made by Lilienthal, which Pilcher refers to in his lecture on Gliding, which follows the Memoir of Pilcher, in No. 5 of the "Aeronautical Classics" just published. Pilcher refers to the glider (see foot of p. 3 of the lecture referred to) as then, in 1897, in the possession of Professor G. FitzGerald, in Dublin; and the question had since arisen, whether this glider had been given to Pilcher and is the one now in the possession of the Aëronautical Society. It is sometimes surprising how things are forgotten in a very little while, and it was some time before I could get any authentic account of what became of the machine, which I remember seeing hanging up in the dome of the New Buildings in Trinity College. However, I can now quote a letter dated 28th December, 1910, from Mr. R. J. Mecredy, editor of *The Motor News*, to the late Professor FitzGerald's son, which the latter has kindly sent me, as follows:—"I saw Dr. MacCabe in reference to the glider which your father, Professor FitzGerald, used. You are quite correct: it was given to Dr. MacCabe and he used it a good deal, but it was finally smashed by a friend of his who went for a flight from the top of a hayrick, and managed to turn over backwards so that the machine was completely wrecked, and not a trace of it now remains." My nephew tells me that the machine is said to have narrowly escaped burning, owing to some brilliant student having set fire to a string which hung down from it, while it was suspended in the New Building's dome. The machine, according to my recollection, was of the form shown in Fig. 1 opposite p. 6 of the lecture above referred to.

MAURICE F. FITZGERALD

Belfast.

AERONAUTICS IN CHINA

October 22, 1910

SIRS,—With regard to affairs in the Far East there is not much to say. The Imperial Board of War is interesting itself in the subject, but in spite of many rumours as to the purchase of machines, I do not think any have arrived. Prince Tsai Tao has made many enquiries during the recent tour, and in Germany he ventured in one of the redoubtable dirigibles. The Secretary to the War Department tells me that, as a result of the Prince's observation, something will be done very soon.

There is a private company recently formed in Tientsin for the purpose of exploiting aeronautics, and the council has purchased a Blériot machine, which arrived two months ago. I understand some of the parts are defective or missing, so that no flights have yet been made.

The Chinese papers (foreign) are taking an intelligent interest in the subject and report all important news. A prominent trade paper (*The Far Eastern Review*) has published a series of articles on Dynamic Flight by Mr. Gordon Black, an automobile engineer, of Shanghai. Two of the Tientsin papers have produced short articles from my pen.

As regards my own work, this is scarcely worth talking of. In April last year (1909) I constructed a bamboo and canvas glider, but it was destroyed by gales before it was quite completed. Since then (lacking time to build another) I have given a good deal of attention to the subject of friction and now produce a formula for design:—

$f = 000015\ A\ V$

(f = total friction,
A = area in sq. ft. subject to skin friction
V = velocity, ft. per sec.).

I must reserve my experimental and theoretical evidence, but I may say that this is fairly extensive.

I have been able to do a little propaganda work, including a short course of lectures to the advanced students of the Imperial Railways of North China Engineering and Mining College, a public lecture before the China Philosophical Society (Tientsin) and some other unimportant items.

HERBERT CHATLEY

Tăng Shan

AERONAUTICS IN JAPAN

28 October, 1910

SIRS,—I regret that I cannot give you very much information on aeronautics in Japan, because as yet there is very little doing. I beg to enclose a few clippings from the local papers shewing that some interest is being taken in the subject, but I have not heard of any actual flights being made in this country up to the present.

A government commission has been appointed to investigate the subject, and the naval and military authorities are giving it attention, but there is no wealthy sporting community in Japan to take it up. As you are aware, Japan is a country of rugged hills for the most part, and what plains there are have all been converted into wet paddy fields, that is, swamps which would make ideal places to alight when in a hurry to do so, but very undesirable ground to take off from again.

ALAN OWSTON

Yokohama

Japan Gazette, 26 October, 1910—Captains Y. Hino and Y. Tokugawa, of the Japanese army, returned to Tokyo yesterday from Europe, whither they were sent in April last on a mission to study aeroplanes in Germany and France. Interviewed by a representative of the *Jiji*, Captain Hino is reported to have stated that in obedience to instructions from the Tokyo Government he has selected and purchased airships "in a certain country." These airships will arrive in Tokyo at an early date. The military authorities will therefore be able to make a trial flight of the airships some time in November at the Tokorozawa Airship Station, situated at a point between Kokubunji and Kawagoye, west of Tokyo. Captain Hino added that he has made over a hundred trial flights in Europe, and stated that at least Y.5,000 will be needed each month for keeping an airship in good condition.

Japan Times, 9 October, 1910—Trial ascents were made by the Yamada airship at Osaki, near Shinagawa, on Friday. In the morning two ascents were made and a third ascent was tried in the afternoon. In the last trial, the airship ascended to a height of 50 metres, and moved at the rate of one ken* per minute against the wind. When the wind abated, the speed increased to four ken per minute. The airship then ascended to a height of 350 metres and made a short flight. After being in the air for about 40 minutes, it came down to the starting point without accident.

* One ken = (about) two yards

Japan Times, 7 October, 1910—Chief Naval Constructor Ushioku in the Naval Board of Construction is reported to have invented a new kind of aeroplane. He has obtained a patent for it. The principal feature of his invention is that it is a new biplane, different from the Wright or Curtiss type, but equipped with hydroplanes so as to be able to fly, to descend to and rise from the surface of the water. When it is completed, it is said that the innovation will become an addition to the flying-machine, especially adapted for use in naval warfare.

Japan Advertiser, 22 October, 1910—The Japanese aviator, Mr. Narahara, is busily preparing for a trial of his aeroplane at the Aoyama Ground towards the end of this month. He has been permitted to use about one-half of the parade ground for the purpose.

(NOTE. As we go to press it is announced that the Japanese Military Aeroplane Investigation Society has been granted an appropriation of £47,000 for the purpose of making experimental flights.—EDS.)

NO AERONAUTICS IN SOUTH AFRICA

10 October, 1910

SIRS,—I beg to inform you that as far as I am aware, the science is almost entirely neglected in South Africa. One man* did make some short flights at Johannesburg with an aeroplane of his own design. I regret I have not an account by me. I do not think that any other aeroplane experiments have been made. Balloons, spherical and navigable, are non-existent down here.

R. V. HOLWELL,
Lieut. R.E.

Transvaal

* This was Mr. Kimmerling, who made his first flight in South Africa at East London on a Voisin biplane, on December 28, 1909, and afterwards made flights near Durban and elsewhere.

We are glad to be able to add that Mr. A. G. Heinze, a member of the Society, has since lectured very successfully at Pretoria, and succeeded in arousing in the military authorities a keen interest in aerial navigation.—EDS.

PATENTS IN 1910

SIRS,—Out of a total of 30,493 applications for patents filed at the Patent Office last year, including those which resulted in provisional protection only, there were, according to a calculation we have just made, 687 occurring under the heading of "Aeronautics." The full numbers of applications for 1909 and 1908 were 30,603 and 28,598. If the average of foreign applications has been maintained, it will be found that the big proportion of 45 per cent. or thereabouts of the total number of applications will have been from persons resident abroad, most of whom are Germans and Americans. Under our new patent system, great difficulty is often experienced in overcoming the preliminary objections of the Examiner, owing to the discovery of previous patents, even though no longer in force, but it is quite the exception for a patent application to be absolutely refused. According to the latest annual report, the Patent Office, out of a gross income of £302,000, handed over to the Treasury a nett profit of £94,000.

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ANALYSIS OF FOREIGN PUBLICATIONS

ABBREVIATIONS

Aer', L'Aéronaute (Paris)
Aeron., Aeronautics (New York)
Aerop., L'Aérophile (Paris)
Aero-Mec., L'Aéro-Mécanique (Brussels)
C.-V., Le Cerf-Volant (Paris)
D.Z.L., Deutsche Zeitschrift für Luftschiffahrt. (Berlin)
Flug., Flug-und-Motor Technik (Vienna)
Rev. Aer., Revue Aérienne (Paris)
Rev. de l'Av., Revue de l'Aviation (Paris)
Tech. Aer., La Technique Aéronautique (Paris)

ACCIDENTS

Explication possible de certains accidents. (Pagezy.) *Aérop.* November 1.

AERODYNAMICS

Etude sur le tunnel de M. Eiffel. (Riabouchinsky.) *Tech. Aér.* December 15.
Axe de roulis des aéroplanes. (Duchene). *Tech. Aér.* December 15.
Moyen de diminuer le travail de pénétration. (Constantin.) *Tech. Aér.* November 15.
Nouveau coefficient pour la formule $KSV^2 \sin \alpha$. (Bousquet.) *Aérop.* December 15.
Résistance sur les zooptères. (Amans.) *Rev. Aér.* December 24.
Direction de la résistance en fonction de l'incidence. (Amans.) *Rev. Aér.* October 22.
Abaissement du centre de gravité et la stabilité. (Thouveny.) *Rev. Aér.* December 17.

AEROPLANES

Mercep-Rusjan monoplane. *Flug.* November 25.
Etrich monoplane. *Flug.* December 10.
Lioré monoplane. *Tech. Aér.* December 1.
Nieuport monoplane. *Tech. Aér.* December 1.
Coanda aeroplane. *Tech. Aér.* Nov. 1.
De Pischof monoplane. *Tech. Aér.* November 15.
Lioré monoplane. *Rev. Aér.* November 15.

AEROSTATION

Ballonfahrten im Deutschen Luft-Verband. *D.Z.L.* December 14.

ALTITUDE

Technische Betrachtungen an Höhenflügen. (Popper.) December 10.

BIOGRAPHY

Capt. Madiot. *Tech. Aér.* November 1.
H. Wynmalen. *Aérop.* November 1.
M. Tabuteau. *Aérop.* November 15.
Dr. Crouzon. *Aérop.* December 1.
J. Faure. *Aérop.* December 15.

BIRD-FLIGHT

Evolutions d'oiseaux de mer. (Thouveny.) *Rev. Aér.* November 19.

COMPASS

Benutzung des Kompasses im Ballon. (Bestelmeyer.) *D.Z.L.* November 30.
Boussole aérienne G. Daloz. *Aérop.* December 1.

CONTROLS

Pressey automatic control. *Aeron.* November.

DIRIGIBLES

Luftschiff "Clouth." *D.Z.L.* November 30.
Dirigeable "Clément-Bayard." *Aérop.* December 1.
Dirigeable "Morning-Post." *Aérop.* December 15.

FABRIC

Herstellung von Ballonstoffen. (Krüger.) *Flug.* November 10.
British fabric testing device. (Hubbard.) *Aeron.* November.

METEOROLOGY

Die Gefahren der Luftschiffahrt. (Dr. Assmann.) *D.Z.L.* December 14.
Observation du vent avant le vol. (Béthuys.) *Tech. Aér.* November 1.

MOTORS

Broc motor. *Tech. Aér.* December 1.
Verdet rotary motor. *Tech. Aér.* December 1.
Berthaud motor. *Tech. Aér.* November 1.
Gnôme rotary motor. *Tech. Aér.* November 15.
Moteurs d'aviation au Salon 1910. (Lorenc.) *Aérop.* November 15, December 1.
Nouveaux moteurs Anzani. *Rev. Aér.* December 24.
Essais des moteurs d'aviation. *Rev. Aér.* December 17.

ORNITHOPTER

Du vol ramé et plané. (Baron.) *Rev. de l'Av.* December 1.

PHYSIOLOGY

Physiologie au Salon 1910. (Crouzon.) *Aérop.* December 1.

PROPELLERS

Résistance des matériaux pour la choix des éléments de l'hélice sustentatrice. (Jarkowski.) *Tech. Aér.* December 1.
Théorie générale des hélices propulsives. (Sée.) *Tech. Aér.* December 1.
Etude expérimentale des hélices propulsives. (Dorand). *Tech. Aér.* November 1.
Hélice à pas variable Chauvière. *Tech. Aér.* November 15.

SIGNALS

Ballonsignale. (Salviate). *D.Z.L.* November 16.
Code de l'air. *Rev. de l'Av.* November 1.
Comment reconnaître son chemin. *Rev. de l'Av.* December 1.

TRAFFIC

Luftverkehrsordnung. *Flug.* November 10.

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